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A Weekly Journal of Science

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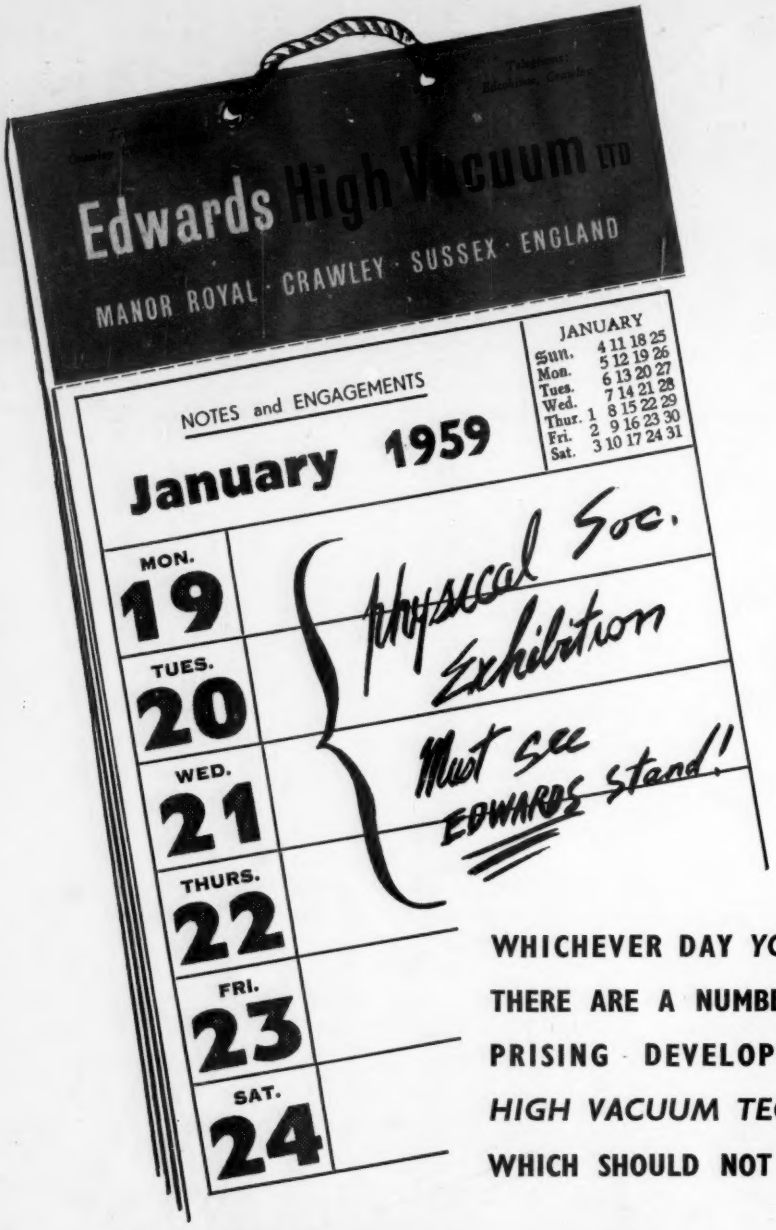

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REORGANIZATION OF INDUSTRIAL MICROBIOLOGICAL RESEARCH IN BRITAIN

THE Council for Scientific and Industrial Research has been considering certain aspects of the organization and support of microbiological research which is at present being carried out at the Water Pollution Research Laboratory, the National Chemical Laboratory, the Ditton Laboratory and the Torry Research Station at Aberdeen. The Council believes that an industrial microbiological team is able to do the best and most effective work when it operates within a research laboratory concerned with the technology served by the team. This is a point of view with which one must agree where industrial research is concerned, and in the present case it is well exemplified by the microbiological research now being undertaken in the Water Pollution Research Laboratory and the food research laboratories.

Although the Microbiology Group at the National Chemical Laboratory, numbering less than twenty, has undoubtedly done good work, the Council considers that the Group is not appropriately placed there; and therefore, apart from those working on the corrosion of metals, the chemical groups in that Laboratory do not benefit from the work of the microbiologists and, possibly, *vice versa*. So the Council believes that microbiological research work of the kind being done at the National Chemical Laboratory, apart from that concerned with the corrosion of metals, would in general be most effectively carried out in some university departments; and it is proposed to encourage support of such work within the universities by means of financial aid.

As a result of this, the Council is aiming at gradually dispersing the Microbiology Group now working at the National Chemical Laboratory. It is suggested that in future the work should be carried out as follows: (1) the Department of Scientific and Industrial Research will continue to maintain the National Collection of Industrial Bacteria, though it should go to the Torry Research Station, Aberdeen, where there is already a comparable collection of marine bacteria; (2) the microbiological work concerned with the corrosion of metals will be retained at the National Chemical Laboratory and expanded there; (3) the fundamental work on sulphur bacteria, at present being done at the National Chemical Laboratory, will end, though allied work, if justified, may be supported at a university; (4) fundamental work on the microbial formation of methane can be carried out at a university. The applied research covered by (3) and (4) is within the field of activity of the Water Pollution Research Laboratory, where any further necessary work in this connexion will be done.

The views of the Microbiology Committee of the Chemistry Research Board were made known fully to the Board itself, the Secretary of the Department of Scientific and Industrial Research and the Review Committee of the Council for Scientific and Industrial Research and, through the last-named, the Steering Committee of the National Chemical Laboratory and the Council. As a result, it is intended that the staff of the Microbiology Group at present working at the National Chemical Laboratory will be disbanded as such: the National Collection of Industrial Bacteria together with some workers will go to the Torry Research Station; some work will be transferred to the Water Pollution Laboratory; other workers will remain at the National Chemical Laboratory.

This proposal, which involves the division and dispersal of certain industrial microbiological research, and especially the removal of the National Collection, from the National Chemical Laboratory has not met with general approval, which is, perhaps, to be expected. Indeed, some microbiologists and others view the proposal with concern and are hostile to the idea of its being carried out before further inquiries have been made and the opinions of other scientists, especially microbiologists, sought. For example, the Institution of Professional Civil Servants and the Institute of Biology consider that the decisions being contemplated by the Council of Scientific and Industrial Research are to be deplored on both economic and scientific grounds. Moreover, they point out that there is no microbiologist on the Council, and they claim that, since the recommendation was made without the Microbiological Research Sub-Committee having been consulted, then this was done before proper advice was sought.

Mr. Stanley Mayne, general secretary of the Institution of Professional Civil Servants, believes that the existence of the present Microbiology Group in association with the National Collection of Industrial Bacteria is of considerable importance to many industrial concerns, as exemplified by the number of inquiries that are made. Nevertheless, in spite of Mr. Mayne's claim, it does not seem feasible that the work of dealing which such inquiries as are made or are likely to be made will become impossible if industrial microbiological research is distributed over a number of establishments. Much other closely connected scientific work is farmed out to different centres, both government and university, yet it does not appear to suffer in consequence. In fact, too much centralization and concentration can be a bad thing.

In a statement issued jointly by the Institution of Professional Civil Servants and the Institute of Biology on December 15, the main criticism was that advice had not been obtained from those most competent to judge before an important move was announced by the Research Council. Be that as it may, as already stated, certain authorities were advised beforehand, and, in any event, it does not follow that the decision is a bad one, especially if the main objective of those responsible for making it was the advancement of microbiological research for the benefit of the nation in general and industry in particular.

The joint statement claims that the disbanding of the Microbiological Group at the National Chemical Laboratory is ill-advised and, if implemented, will damage the national economy, for "its function cannot satisfactorily be discharged by any other body". This criticism seems premature, especially in view of the future arrangements for microbiological research being contemplated by the Council for Scientific and Industrial Research. The views expressed by the Council do not imply that microbiological research will be abandoned altogether; neither is it suggested that the work now being done will be handed over to an incompetent body. It appears that the move aims at so dispersing the Group that each new subdivision will find itself working in the most appropriate and advantageous environment.

It certainly seems a pity that the National Collection of Industrial Bacteria should be separated from the research unit as a whole; though some microbiologists will no doubt still be in direct association with it. In any event, if there is to be dispersal, then the Council has no choice other than to recommend the removal of the Collection to a place where it is of maximum service to science and industry; if, as is suggested, only the microbiological work on metal corrosion is to remain at the National Chemical Laboratory, then there seems little justification for the Collection remaining where it is. Most type collections and other national collections are inevitably centred at one, or just a few, places, in spite of the fact that cognate research may be very widely dispersed. It is difficult to see how this can be avoided. As the joint statement issued by the Institution of Professional Civil Servants and the Institute of Biology points out, removal of the Collection to Aberdeen might prove inconvenient, especially since, as the statement claims, the majority of requests for technical help, the supply of cultures and the checking of purity come from the south of Britain. Moreover, visitors from abroad would probably find the siting of the Collection at Aberdeen somewhat of a nuisance. Apart from this, however, if the Collection is to be moved at all, Torry Research Station appears to be a very appropriate institution. The joint statement suggests that the Microbiology Group should either stay where it is or, if it is to be transferred out of the Department of Scientific and Industrial Research, it should be linked with the Microbiology Research Establishment of the Ministry of Supply at Porton. But the Council's statement says that if it goes to the Torry Research Station, the National Collection will still be maintained by the Department of Scientific and Industrial Research. Movement to Porton would bring the National Collection and its personnel in touch with medical instead of marine biological research, so, apart from difference in geographical site, the suggested move to Porton as opposed to Aberdeen seems to have little to recommend it.

The Institution of Professional Civil Servants and the Institute of Biology have made it quite clear that they deplore the splitting up of the present Group, and suggest that it should be established as a self-contained entity within the Department of Scientific and Industrial Research. Although there is much to be said in favour of this, the Council for Scientific and Industrial Research has also much in its favour in suggesting that microbiologists should work in a research laboratory most closely connected with the technology involved: this latter proposal must inevitably lead to a certain amount of farming out of the work. There is certainly much to be said for fundamental investigations of sulphur bacteria and the microbial formation of methane and, indeed, other aspects of microbiology, being supported by and in certain universities. Indeed, the Institution of Professional Civil Servants and the Institute of Biology concur with this proposal. The selected universities would offer certain biological and other facilities not to be found elsewhere. Such a development would seem to follow closely along the lines of policy adopted by the Australian Commonwealth Scientific and Industrial Research Organization, under the auspices and financial support of which varying scientific and industrial research laboratories are actually situated on the campuses of every university in Australia.

Other aspects of the case have, so far as we are aware, not been mentioned; for example, possible domestic problems and probably upheavals due to personnel being moved from the south of England to Aberdeen and the longer distances to be travelled in order to attend most conferences and meetings of learned societies, etc. But if the move is deemed of real advantage to the development of microbiological research, such obstacles must be accepted and overcome.

Obviously there is a schism in opinion concerning this case; and there is much to be said in favour of the proposal and against it. It can be taken for granted, however, that the Council for Scientific and Industrial Research delved deeply into the various aspects of the case before advising the splitting up of the Microbiology Group at the National Chemical Laboratory; so it will be a matter of time before judgment can be brought to bear on the proposal, if carried out. On the face of it, despite the disadvantages involved and inconveniences incurred, the distribution envisaged by the Council might well contribute to the advancement and advantage of industrial microbiology. The merits of division and dispersal may outweigh the demerits of disruption to the benefit of fundamental and applied microbiological research.

PROFESSIONAL METEOROLOGY AND EVERYDAY NEEDS

Everyday Meteorology

By Prof. A. Austin Miller and M. Parry. Pp. 270+22 plates. (London: Hutchinson and Co. (Publishers), Ltd., 1958.) 30*s*. net.

Farming Weather

By L. P. Smith. (Nelson's Agriculture Series.) Pp. ix+208+8 plates. (Edinburgh and London: Thomas Nelson and Sons, Ltd., 1958.) 15*s*. net.

BRITISH people are notorious for using their weather as a conversational gambit and as an alibi for Latin holidays. This combination of naïve intolerance and bemused escapism is reflected in the startling fact that the Meteorological Office is run, quoting Prof. A. A. Miller, "on a total annual budget of little more than the cost of a single modern bomber". Moreover, the proportion of this pittance allocated to specialized weather forecasting and advisory services, for example, for farmers and growers, is small compared, for example, with that devoted to upper-air research. The current preoccupation of our mathematical meteorologists with the physics of the atmosphere and the traditional restriction of Dunstable to sweepingly generalized forecasts marketed afterwards in newspapers and on television screens has perpetuated our habitual neglect of applied meteorology in terms of our everyday needs.

It is not surprising that, of the two volumes under review, one has been written by two geographers pledged to teach the weather not only *per se* but also in relation to society, and the other by a meteorologist pledged to direct weather advice to farmers and growers. Both books achieve an easy, readable style.

"Everyday Meteorology" deals with the origin and collection of weather data, the causes of weather, and the significance of frontal zones and air masses in the atmospheric circulation. Local and world types of weather are then described and finally some problems of weather forecasting, of 'living with' the weather and of 'harnessing' the weather, are discussed. Attempts at three-dimensional representation of weather systems are, unfortunately, few and in two instances quite misleading. In Figs. 38 and 39 upper winds relating to horizontal profiles are inserted on vertical cross-sections through frontal systems. The impression given in the second diagram is of a wind blowing down towards the Earth's surface through a large cumulus cloud. Parts of Chapter 9 are conspicuously inadequate in reference to soil climate, the growing season and land aspect. "A soil containing much water" is not necessarily "a clay soil" (p. 192), and the optimum insolation slope varies with the time of year between south-west and south-east (p. 197). These and other minor omissions and inconsistencies tend to detract from what is otherwise an attractively compiled work which renders accessible to the layman many meteorological ideas which might otherwise be beyond him.

"Farming Weather" aims at a particular section of the popular market. It presents a digestible and comprehensive survey of weather elements and factors and weather forecasting as they affect agriculture. The lack of precise recommendations to farmers on coping with weather hazards may be criticized by some. It should be stressed, however, that every farm, indeed every field, may require different weather advice because of small-scale variations in land morphology, soil conditions and associated micro-climates. Generalized advice, even for a local district, may be relatively useless. Adequate consultation of L. P. Smith's book should enable the farmer, or grower, to plan his programmes so as to anticipate certain weather hazards and accommodate them when they occur.

Professional meteorology would benefit by devoting more effort than heretofore to the applied problems so ably discussed in these two volumes. "Meteorology without Mathematics" may be regarded as impracticable and futile by the meteorologists, but mathematics without a morphological approach to weather study seems unlikely to provide us with a properly trained and localized advisory weather service.

JAMES A. TAYLOR

THE LIVING MOLLUSC

Molluscs

By Dr. J. E. Morton. Pp. 232. (London: Hutchinson and Co. (Publishers), Ltd., 1958.) 10*s*. 6*d*. net.

ALTHOUGH Dr. J. E. Morton states that there has been no general book on malacology written in Britain for forty-five years and so claims comparison with B. B. Woodward's brief "Life of the Mollusca", his book bears comparison better with Pelseneer's "Mollusca" published in 1906. Of necessity both much shorter and far less fully illustrated, yet it marks a notable stage in the growth of knowledge concerning the most structurally diverse of the invertebrate phyla. Pelseneer's volume represented the culmination of a notable period of comparative anatomy; it left the stage set for elucidation of the function of organs there so clearly described.

Dr. Morton's book represents the first comprehensive attempt, probably in any language, to summarize what has more recently been discovered about the function and significance of these organs, adding up in many cases to a very full understanding of the mode of life of the animals possessing them. He is particularly well qualified to deal with such matters by the beauty of his research and the distinction of his writing. Thus we read that "If pulmonates lack the structural variety shown by opisthobranchs, this is because they have made a much more subtle use of physiological adaptations", that the Gastropoda are a "living museum of adaptive morphology, nearly every family having some distinctive pattern to show", that nudibranchs are "the most colourful and extravagant of all gastropods", that "cephalopods are organized upon a more stereotyped pattern than gastropods or lamellibranchs; but this is a pattern of high success". He surmises that the extinct ammonoids "could make leisured saunters".

There is much to praise in this book and for any student of the Mollusca, as I have found, to learn from it. The restriction on length has made possible a price well within the range of all, amateur, student or professional zoologist, interested in malacology. It is, however, unfortunate that there is so little space and so indifferent a printing surface for the text-figures at which the author excels.

All this is not to say there is not matter for criticism. The impression is given that the bivalves possess a 'two-piece' shell, whereas the ligament is an integral part of the shell. Those who study oysters will be surprised to discover that at no stage is there a foot or a byssus gland, also that the adult may "break free". Although classification of the bivalves is far from satisfactory, matters are not improved by employing that of Douvillé.

C. M. YONGE

RESPONSES OF INVERTEBRATES

An Introduction to the Behaviour of Invertebrates

By Dr. J. D. Carthy. Pp. xi+380+4 plates. (London: George Allen and Unwin, Ltd., 1958.) 45*s.* net.

HERE is a useful summary of a large volume of literature on some responses of invertebrates to experimental stimulation. It is not, therefore, a textbook of behaviour, which is a larger subject including spontaneous activities, memory and central control mechanisms. There are chapters on the responses to stimulation in each of the main sensory modalities, including humidity changes and the contact chemical sense, in addition to those more familiar from our own experience. The final chapter, on whole patterns of behaviour, is disappointing, since the behaviourist approach and that of the neurologist are both excluded, leaving an account of the reactions to combined stimuli.

The coverage is excellent. The recent literature is summarized together with the old, but in some instances the necessary re-interpretations are not forthcoming. First, for example, in this decade a number of workers have shown that the angle of light acceptance of an ommatidium is wide compared with the interommatidial angle. Much of the earlier work on visual acuity and form vision by the apposition compound eye must now be attributed to post-retinal mechanisms. For a longer period it has been known that the principal physiological responses of many eyes change with time, and, in particular, some rapidly moving diurnal insects have little but an 'on' and an 'off' response. Form vision must then depend on relative movement of the eye and the object, and again must be attributed to post-retinal integration. Hassenstein's analysis of the *Wechselfolge* of *Chlorophanus* is an example of the new approach to this mechanism. Secondly, a most important theory of the relation between spontaneous movements and the responses to stimuli is that of von Holst; this is barely mentioned under the name re-afferentation, but not explained. Recent results from the Tübingen school demonstrate the explanatory value of these concepts in this field, and they deserve a better treatment.

In my own special field the literature summary is accurate, a judgment which can probably be extended to the remainder. The difficulty is not the labour of being acquainted with the material; it is the comprehension of its relation to the main body of knowledge. The solution of this problem distinguishes a synthesis from a compilation.

However, this is mild criticism. The book represents the painstaking and useful labour of summarizing a vast, diffuse and unsatisfactory field of zoology. The responses of whole animals to the somewhat artificial circumstances required by experimental analysis are notoriously difficult to interpret. Often a particular species is studied by only one author, so that comparisons are difficult and may not be valid. The experiments must often be made statistically with a large number of animals so that the mechanism within an individual is not easily approachable. This brings me to the final point. The introduction of delicate electrophysiological methods for the analysis of the actual performance of sense organs as transducers has led to a quiet revolution in our appreciation of the various parameters of a stimulus which can possibly be of importance to the animal. The problem of the origin of the integrated response is thereby usually pushed back into the central nervous system, but at least an advance is made. Neither this book, nor its predecessors, claims to synthesize this more recent neurophysiological analytical approach with the 'behaviour' of the whole animals. Perhaps the effort is doomed to frustration for a long time to come.

G. A. Horridge

FACT AND VALUE IN THE SOCIAL SCIENCES

Value in Social Theory

A Selection of Essays on Methodology. By Gunnar Myrdal. (International Library of Sociology and Social Reconstruction.) Pp. xlvi+269. (London: Routledge and Kegan Paul, Ltd., 1958.) 32*s.* net.

IN this book, Dr. Myrdal faces a simple but at the same time unsolved problem which has overshadowed the social sciences since their inception, namely, the relation between statements of fact and statements of value. As an economist, he found himself in his earlier days compelled to reject the solution of the "welfare economists"; in later years he was equally repelled by the "naïve empiricism" of the American institutional school, with the result that the value problem has come to be a "major preoccupation" for him, and questions of methodology have been for many years one of his continuing interests.

Dr. Myrdal's position at the present time is directly dependent on an acceptance and development of the view that 'objective' values cannot be established and known by scientific processes; subjective evaluations can be observed and analysed, but their validity and their significance for social theory only arise out of their acceptance by specific individuals and groups. In consequence, when Dr. Myrdal produced his great survey of race relations in the United States, "The American Dilemma", he made his value premises explicit, and based them so far as possible on observation. He made no attempt to argue that they could be incorporated in a body of fact and doctrine created by the research itself. He now concludes in the present book that valuations are necessary in all scientific work, and that "the final solution of the value problem in economic and in the social sciences generally must . . . be to set up a method by which human valuations are rationally and openly introduced into theoretical and practical research to give it direction and purpose to make it both unbiased and relevant to life". No research can, therefore, be *wertfrei*.

This is the point at which Dr. Myrdal leaves the argument in his "Postscript". It may be pointed out, however, that it is somewhat paradoxical to speak of the 'introduction' of values into research in this way because the very nature of science as a human activity is dependent on the logical presupposition that it should be unbiased. Moreover, as Mr. Streeten points out in the introduction to Dr. Myrdal's essays, the analysis and public discussion of beliefs and valuations tend to produce changes in them, and scientific inquiry thus plays its part in their formation. There is thus a connexion between fact and value, to this extent at least. If, however, it must be concluded that the social sciences cannot be 'objective' in Max Weber's sense because the connexion is not a logical one, there is nevertheless a limited area within which their explanation of man's behaviour is scienti-

fic, because, as Dr. Myrdal puts it, "there *is* a great deal of practically mechanistic causation in human life"; in particular, resistances to social change are "enormous", and the tendency for social phenomena to repeat themselves is correspondingly great. The true paradox in the social sciences which lies at the end of the Myrdal–Streeten argument is then that as the deeper understanding of social phenomena makes it possible to free them from the operation of 'mechanistic causation' in some measure, the social sciences must be supposed to contain within them, to the same extent, the seeds of their own destruction.

T. S. SIMEY

BIOCHEMISTRY IN MEDICINE

Advances in Clinical Chemistry

Vol. 1. Edited by Harry Sobotka and C. P. Stewart. Pp. xi+398. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1958.) 12 dollars.

WHILE most aspects of biochemistry have been adequately covered in many recent review journals, clinical chemistry has featured in the literature of recent years more in the form of new outlets for original papers and in a spate of fairly elementary texts. The present volume is therefore to be welcomed, since it is the first of a series in which selected topics will be reviewed thoroughly and authoritatively by experts who are actively working in the field which they describe. The authorship of this first volume is thoroughly international in composition; of the nine authors five are in Europe, three in America and one in Australia, while the two editors live in New York and Edinburgh respectively.

Any publication dealing with clinical chemistry is liable to become a mere compendium of methods. While methods feature very prominently, and rightly so, in this book, their appearance is balanced by an equally exhaustive discussion of what the editors term "the fundamental biochemical abnormalities which underlie disease". The choice of subjects has been very skilfully made to give a wide coverage of problems of topical interest. Thus the chapter by Wróblewski on the clinical significance of transaminase activities in serum is a welcome reminder that this enzyme is of interest in several conditions other than coronary thrombosis. The topical subject of 5-hydroxytryptamine and related compounds is covered by Dalgleish in a survey which differs from other recent reviews in being predominantly biochemical rather than pharmacological. Thyroid function is dealt with in Chaney's chapter on the analytically complex problem of the determination of protein-bound iodine and in Silver's contribution on plasma-levels of iodine-131. Plasma iron is competently dealt with by Ramsay. Two chapters which are essentially methodological, but which will be welcomed for their detailed and critical treatment of their subjects, are Neher's review of the determination of individual adrenocortical steroids and Owen's section on paper electrophoresis of proteins. Josephson contributes a brief but useful chapter on the composition of body fluids in childhood, and in collaboration with Ek also discusses the assessment of the tubular function of the kidneys.

Without attempting to detract from the value of the book, I would like to express an objection to the term 'clinical chemistry'. The subject so named, unless it be regarded merely as a technical exercise in chemical analysis, is essentially a division of the wider discipline of biochemistry in which biochemical principles are applied to the scientific study of disease in the hospital laboratory. While 'clinical chemistry' is certainly preferable to the alternative term 'chemical pathology', the most appropriate title is undoubtedly 'clinical biochemistry' or 'pathological biochemistry'.

J. N. DAVIDSON

THE COLOURS OF DOGS

The Inheritance of Coat Color in Dogs

By Clarence C. Little. Pp. xiii+194. (Ithaca, N.Y.: Comstock Publishing Associates, Cornell University Press; London: Constable and Co., Ltd., 1957.) 34*s*. net.

MOST scientific breeders and geneticists will already know Dr. C. C. Little's book, which is making its appearance here under an English imprint. It gives the results of many years of research at Bar Harbor and in the author's own dog colony into the inheritance of the coat-colour patterns of most of the commercially important breeds of dog. In all, ten loci, some with several alleles, are discussed, and 4,100 pups of twenty-eight breeds have been raised in the laboratory colony—the rest of the results have come from co-operating breeders, through the American Kennel Club. This successful co-operation, which seems to have been very critically carried out, is one of the most interesting features of the study. Genetics are not the only field in which use could be made of the large number of dogs bred annually—longevity studies and surveys of the incidence of tumours have recently been attempted for various breeds, and although colour-scoring places a less exacting demand on those breeders who co-operate, the scale of Dr. Little's support is encouraging as an index of what could be done with this otherwise wasted biological information.

Breeders themselves stand to gain from the results of the study; the author has attempted to accommodate them, in a book directed chiefly to professional geneticists, and secondarily, perhaps, to veterinarians, by including a short refresher chapter on the mechanisms and terminology of inheritance, but this will only make his findings clearly intelligible to non-biological readers if they have a reasonable prior knowledge of genetics.

The results are concisely presented, first by loci and then by breeds. It is difficult for anyone not in the field to criticize the detailed conclusions reached. For the generality, one of the most useful items is a summary list of twenty-one breed- and colour-types where the genes represented are known with reasonable certainty. Little considers that 'true' albinism, with complete absence of skin pigment and with pink eyes, probably does occur in dogs, and that the 'blue-eyed' albino dogs and cats mentioned by Burns arise by a different mechanism. The effects of various modifiers upon the extent of pigment patches are well illustrated by drawings. Cases of supposed red-black somatic mutation in cocker spaniels are discussed: here as elsewhere the book is a provocation to the pigment chemist to find out the nature of the differences induced genetically between adjacent skin areas. It sticks strictly to its last, however: there is no general discussion of pigment epigenetics, and only incidental treatment of the problem of analogy between canine and other mammalian pigmentation

genes; the substance of Dr. Little's recent and authoritative review of coat-colour genes in rodents and carnivores would be a useful additional chapter for future editions without making the book overlarge, and would widen its use for reference purposes. It is already a valuable standard work, and a tribute to the patience of its author which only those of his colleagues who work with the longer-lived mammals will fully appreciate. ALEX COMFORT

FLORA OF WEST AFRICA

Flora of West Tropical Africa

The British West African Territories, Libreria, The French and Portuguese Territories South of Latitude 18° N. to Lake Chad, and Fernando Po. By Dr. J. Hutchinson and Dr. J. M. Dalziel. Second edition revised by R. W. J. Keay. Vol. 1, Part 2. Pp. ii+297–828. (London: Crown Agents for Oversea Governments and Administrations, 1958.) 55*s*.

SCIENCE, fortunately, need not always wait on politics, and for thirty years the essential unity of the Upper Guinea region of Africa has been recognized and provided for by an excellent "Flora". It is not without interest to trace the historical background.

During the middle part of last century large collections of dried plants (herbarium specimens) began to arrive at Kew from what was then the British Empire, and Sir William Hooker, followed by his son Sir Joseph Hooker, initiated and undertook the vast project of providing "Floras" of these territories. The four major works, which started publication in 1860, were, in chronological order: "Flora Capensis", "Flora Australiensis", "Flora of Tropical Africa" and "Flora of British India". Of these the "Flora of Tropical Africa" (Vol. 1, published in 1868) was by far the least satisfactory for, with a few exceptions, only the periphery of the area was well known, and the earlier volumes often contained no more than about 10 per cent of the species now known to science. In the later decades of the nineteenth and the earlier decades of the twentieth centuries German botanists, inspired by Adolf Engler and encouraged by the political climate of German imperial expansion in Africa, did a vast amount of botanical work on tropical Africa, often without very close co-operation with similar work at Kew and the British Museum. By the 1920's the taxonomy of the flora of tropical Africa was in real confusion, and it was realized at Kew that a solution had to be found. Whether it would have been better to start a new edition of the "Flora of Tropical Africa" (the first edition of which has not been entirely completed to this day) is a matter of opinion, but the decision was taken, probably rightly, to start a new series of African regional "Floras". With institutional and, indeed, international co-operation, botanical work on Africa south of the Sahara has proceeded along that course with a fairly satisfactory regional division of the territory, leaving, however, a few unfortunate lacunae, of which the French Cameroons – French Congo region is the worst.

This brief historical summary is necessary to see the "Flora of West Tropical Africa" in perspective. It was the first of this new series of regional floras but differed fundamentally, in many respects, both from its aged parent and from its later successors ("Flore du Congo Belge", now well advanced; "Flora of East Tropical Africa", in course of publication; and "Flora Zambesiaca", in gestation). The original edition was initiated by Sir Arthur Hill, then director of Kew, financed by the British West African Governments, entrusted to Mr. (now Dr.) J. Hutchinson and the late Dr. J. M. Dalziel and completed over the period 1927–36. This represented very rapid work, and speed of production and conciseness were two of its main features. Synonymy, references and descriptions were cut to a minimum; but there were rather elaborate keys containing descriptive elements and the illustrations were generous. The arrangement of the families departed considerably from Bentham and Hooker traditions by following Hutchinson's own ideas on classification—usually, though not invariably, an improvement on the older one.

The work was at the time the only large-scale modern "Flora" of tropical Africa available and was in great demand not only in the territories for which it was intended but also throughout Africa, providing, often enough, the means for the field-botanist to achieve at least generic determinations anywhere in Africa south of the Sahara. It is not surprising that the first edition soon sold out, and it is gratifying that Kew has been able to undertake a much-needed revision and second edition.

This second edition was entrusted to Mr. R. W. J. Keay, of the Department of Forest Research, Nigeria, assisted by Mr. F. N. Hepper and several other members of the Kew staff. Keay, with an excellent knowledge of the plants obtained in the field, most unusually joined with an admirably balanced taxonomic judgment, has made a magnificent job of it, correcting the many errors which had not unnaturally been discovered with the passage of time in the original work and reorganizing some portions completely, although keeping the original format and reconciling so far as possible the conflicting claims of accuracy and speed. It is a splendid work of the highest value and importance taxonomically, ecologically and economically. To see the extent of change and progress represented by the second edition, one may turn to the important genus *Cola*, entirely rewritten with the help of Mr. J. P. M. Brenan, and note that twenty-five species have expanded to forty-two and that nine more are recorded as still imperfectly known.

The part now under review is of great economic importance, containing the Leguminosae (divided into Caesalpiniaceae, Mimosaceae and Papilionaceae) and the Meliaceae (African mahoganies). In reviewing a second edition it is hard to decide exactly what criticism is legitimate, in view of the fact that the format of the original cannot be drastically changed. Though Keay has partially removed them, there still remain traces of a certain Kew insularity. It is, one supposes, to be taken as almost axiomatic that any specimen cited is represented in the Kew Herbarium; but this is not always so, and it may be suggested that the internationally accepted system of herbarium abbreviations should have been used to indicate the location of specimens. Of minor errors there are, of course, a few, inevitably so in a work on this scale, but the general standard is very high and to pick out the odd slip for criticism would reflect more on the mentality of the reviewer than on the ability of the editor. The price (55*s*. for 532 pages) is a considerable increase on that of Part 1 (25*s*. for 295 pages) and a stronger paper cover might have been provided in view of the increased bulk. A. W. EXELL

NEW INVESTIGATIONS WITH SCEPTRE III

From the Research Laboratory, Associated Electrical Industries Ltd., Aldermaston Court, Aldermaston

Axial Positive Ion Velocities in Sceptre III

By T. P. HUGHES and Dr. S. KAUFMAN

The spectral lines of highly ionized atoms in the high-current discharges in Zeta and Sceptre[1] show marked Doppler broadening. It has yet to be shown conclusively that the ion motion involved is due to a high ion temperature. If this is the case, one of the conditions which should be satisfied is that the broadening should be independent of the direction from which the discharge is viewed. In the work referred to above, the discharge was viewed only in the radial direction, that is, perpendicularly to the gas current. One aim of the experiments reported here was to make observations of the broadening in the directions parallel to, as well as perpendicular to, the gas current.

The other aim was to measure ion drift velocities. It has been shown[2,3] that those deuterons which undergo nuclear reactions have a mean centre-of-mass velocity parallel to the gas current of about 5×10^7 cm. sec.$^{-1}$. One interpretation of these observations is that a small fraction of the deuterons are accelerated to velocities of about 10^8 cm. sec.$^{-1}$, and that these react with other comparatively slow deuterons[3]. Another possible interpretation is that the gas is moving parallel to the current with a velocity of 5×10^7 cm. sec.$^{-1}$. If impurity ions such as O V were to possess a comparable drift velocity, a marked wave-length displacement would be detected by tangential spectroscopic observations. This point has also been made very recently by George[4]. In this work, preliminary observations have shown that the magnitude of the O V Doppler widths is independent of the line of sight and that some impurity ions (for example, O V, C V) possess axial velocities of about $(1 - 2) \times 10^6$ cm. sec.$^{-1}$ in the direction of positive ion current.

The optical arrangement is shown in Fig. 1. Light leaving the centre of the discharge tangentially was directed into a Hilger medium quartz spectrograph either by the mirrors, A, B and C or by A', B' and C', thus allowing observations in opposite tangential directions to be made. The mirror C could be replaced by the mirror C', or removed completely to permit radial observations. Spectra from these three lines of sight were recorded for comparison using a Hartmann diaphragm placed in front of the spectrograph slit. Only short exposures of about 50–100 discharges were possible because the quartz window in the torus wall soon became covered with an opaque metallic deposit. The customary few hundred discharges needed to reach stable operating conditions after opening the vacuum system to the atmosphere were therefore omit-

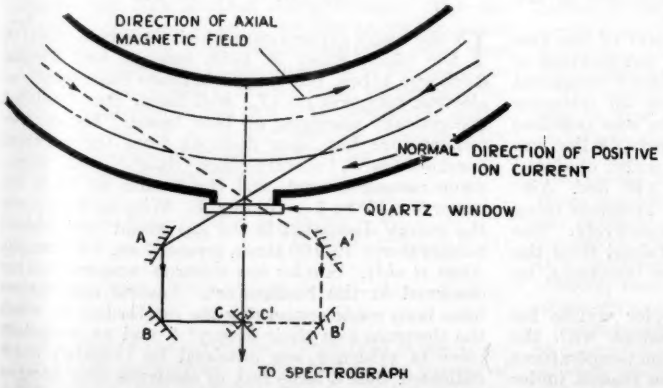

Fig. 1

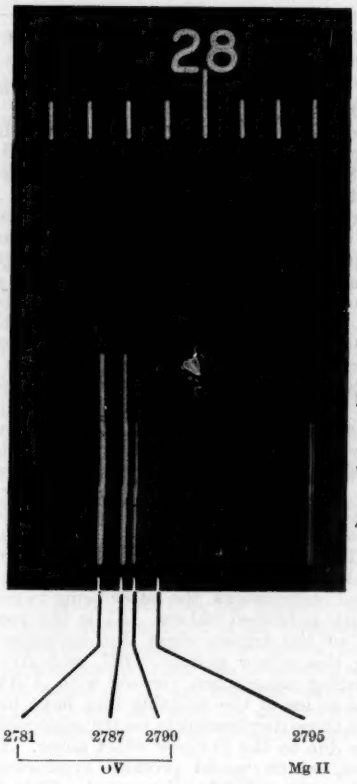

Fig. 2

Table 1. Comparison of Observations in Radial and Tangential Directions

No. of primary turns	Direction of electric field	Initial axial magnetic field (oersted)	Ion	Displacement		Mean ion velocity (cm. sec.$^{-1}$)	O V half-intensity width			Mean O V ion 'temperature' (deg. K)
				$\Delta\lambda$ (A.)	$\Delta\lambda'$ (A.)		ΔW_R (A.)	ΔW (A.)	$\Delta W'$ (A.)	
16	normal	1,000	O V	$-0{\cdot}07\pm0{\cdot}05$	$+0{\cdot}08\pm0{\cdot}05$	$(0{\cdot}8\pm0{\cdot}4)\times10^6$	$0{\cdot}8\pm0{\cdot}1$	$0{\cdot}7\pm0{\cdot}1$	$0{\cdot}8\pm0{\cdot}1$	$(1{\cdot}4\pm0{\cdot}3)\times10^6$
16	normal	500	O V	$-0{\cdot}14\pm0{\cdot}05$	$+0{\cdot}16\pm0{\cdot}05$	$(1{\cdot}6\pm0{\cdot}4)$	$0{\cdot}7\pm0{\cdot}1$	$0{\cdot}7\pm0{\cdot}1$	$0{\cdot}7\pm0{\cdot}1$	$(1{\cdot}1\pm0{\cdot}2)$
			C V	$-0{\cdot}18\pm0{\cdot}06$	$+0{\cdot}21\pm0{\cdot}06$	$(2{\cdot}6\pm0{\cdot}6)$				
16	reversed	500	O V	$+0{\cdot}13\pm0{\cdot}05$	$-0{\cdot}10\pm0{\cdot}05$	$(1{\cdot}2\pm0{\cdot}4)$	$0{\cdot}5\pm0{\cdot}1$	$0{\cdot}6\pm0{\cdot}1$	$0{\cdot}6\pm0{\cdot}1$	$(0{\cdot}6\pm0{\cdot}1)$
8	normal	500	O V	$-0{\cdot}13\pm0{\cdot}05$	$+0{\cdot}12\pm0{\cdot}05$	$(1{\cdot}3\pm0{\cdot}4)$	$0{\cdot}7\pm0{\cdot}1$	$0{\cdot}7\pm0{\cdot}1$	$0{\cdot}8\pm0{\cdot}1$	$(1{\cdot}2\pm0{\cdot}2)$

Gas, deuterium at a pressure of 1·4 millitorr; condenser voltage, 25 kV.

ted, with the result that the impurity concentration was abnormally high.

The spectrograms showed that measurable displacements occurred in the wave-lengths of the O V triplet at λ2781 A., and, in the one set of exposures where it could be seen, of the C V triplet at λ2271 A. These lines are most strongly excited in the central region of the discharge column[5]. The displacements of the O V lines when the direction of the electric field is normal may be seen in Fig. 2, which is an enlargement of a typical spectrogram. Many other lines showed smaller displacements. However, the wave-lengths of several lines of singly ionized metal atoms did not vary perceptibly from one direction of view to another: these lines are but feebly excited at the axis of the torus. One of them, the Mg II line λ2795·53 A., was therefore used as a reference wave-length from which the position of each member of the O V triplet, when viewed in the three different directions, could be obtained by microphotometry: another, the Cu II line λ2276·25 A., served as a reference wave-length for the C V triplet. The results are shown in Table 1. The wave-length displacements are given with respect to the wave-lengths obtained from the radial observations, the latter being in good agreement with published values. $\Delta\lambda$ is the mean displacement of the triplet when the discharge is viewed using the mirror system *ABC*, and $\Delta\lambda'$ is the corresponding value when viewing with *A'B'C'*. The mean velocities of the emitting ions have been obtained from these displacements on the supposition that they are due to the Doppler effect alone. The Zeeman effect, which would produce symmetrical splitting of the lines, must be discounted. Only the quadratic Stark effect need be considered. This cannot account for more than a small fraction of the observed displacements because it would produce a shift in one direction only, irrespective of the line of sight. The ion velocities are in each case in the direction of positive ion current flow.

On the basis that the intensity ratio of the two strongest lines of the O V triplet is independent of the direction of view and has a value of 2·0 (measured in previous radial observations when an intensity calibration of the photographic plate was possible) the half-intensity width of the strongest O V line was measured. In Table 1, ΔW_R is the width observed in the radial direction of viewing; ΔW and $\Delta W'$ were obtained for the two tangential directions using mirror systems *ABC* and *A'B'C'* respectively. The mean O V ion 'temperature' was obtained from the average of these widths over all three directions, by the method of Voigt profiles.

The agreement between the Doppler widths for different viewing directions is consistent with the broadening being caused by real O V ion temperatures of about 10^6 deg. K. occurring in the plasma under the operating conditions described above. The existence of such temperatures is not proved conclusively because light from many discharges is required for a single measurement and the possibility of random mass motion still remains. The directed velocities of the O V ions are more than an order of magnitude less than the centre-of-mass velocity of the reacting deuterons. Nevertheless, they are unusually large for positive ions, and their implications are considered by Ware in the following communication. In future work it is hoped to measure these velocities more exactly with a spectrograph of larger dispersion and to ascertain their dependence on ion mass and charge.

We are indebted to Dr. A. A. Ware for helpful suggestions during the preparation of the manuscript and for his constant interest in the work. It is a pleasure to acknowledge the co-operation of Mr. R. F. Hemmings and Mr. J. E. Read, who were responsible for the engineering and operation of Sceptre.

This work was supported in part by a contract from the Atomic Energy Research Establishment, Harwell, and is published with the permission of Dr. T. E. Allibone, director of the Research Laboratory, Associated Electrical Industries, Limited.

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The Positive Ion Heating Mechanism in Sceptre III

By Dr. A. A. WARE

In the many experiments which have been made on the pinch effect in both straight and toroidal discharge tubes, the results indicate consistently an electron temperature (T_e) well below that predicted theoretically assuming no heat losses. The electron temperature has been deduced from the electrical conductivity[1,2], spectroscopic data[3,4] and microwave measurements[4], and the results all lie in the range 5×10^4 to 5×10^5 deg. K. With no heat losses the energy dissipated in the gas would have yielded temperatures 10–100 times greater (see, for example, Allen *et al.*[5]). Similar low electron temperatures are observed in the Stellarator[6]. Several speculations have been made concerning the mechanism by which the electrons lose their energy[6–8], and an important piece of evidence was obtained by Colgate[3], which indicated that a large flux of electrons with energies in the range 2–4 keV. was striking the walls. This

Table 1

Measured quantities					Derived quantities		
Applied magnetic field (gauss)	Gas current I (amp.)	Electric field in gas, E (volt cm.$^{-1}$)	Discharge radius, a (cm.)	O V-ion velocity v_0 (cm. sec.$^{-1}$)	Deuteron density n_d (cm.$^{-3}$)	Deuteron velocity v_d (cm. sec.$^{-1}$)	Electron velocity v_e (cm. sec.$^{-1}$)
500	$1{\cdot}0 \times 10^5$	3·0	8	$1{\cdot}6 \times 10^6$	$3{\cdot}5 \times 10^{14}$	$4{\cdot}6 \times 10^6$	$-4{\cdot}4 \times 10^6$
1,000	$1{\cdot}4 \times 10^5$	2·3	10·5	$0{\cdot}8 \times 10^6$	$2{\cdot}0 \times 10^{14}$	$6{\cdot}0 \times 10^6$	-7×10^6

$N_d = 7 \times 10^{16}$ cm.$^{-1}$

flux was estimated to be of the right order of magnitude to explain the energy loss.

The results of measurements of Doppler broadening of spectral lines from Zeta[9], Sceptre III[8] and the Stellarator[10] are consistent with the positive ions having temperatures appreciably greater than the electron temperature and in the range 10^6 to 5×10^6 deg. K. Because of the possibility of a mass motion occurring in the gas with random magnitude and direction, the results do not prove the existence of these temperatures. If the temperatures are real, the result $T_{\text{ion}} > T_e$ is novel for discharges of this type. Thus, one of the main processes by which the ions were expected to be heated was by collision with electrons[10], but if the ion temperature is greater than the electron temperature, this process becomes a cooling mechanism. Furthermore, the compression of the gas due to the pinch effect is not sufficient to cause the observed ion temperatures, and hence another heating mechanism must be sought.

In the preceding article, Hughes and Kaufman report that the O V and C V ions in Sceptre III have unusually large mean velocities parallel to the gas current. This result suggests a simple picture of the discharge, which is consistent with the high electron energy loss and explains the positive ion heating mechanism.

The Deuteron Velocity

A simple discharge model is taken in which the particle densities and temperatures, and the current density, are assumed uniform over the cross-section of a stationary and stable discharge. (The constant current density is indicated by magnetic probe measurements[11]. The assumption of constant particle density and temperature is not likely to introduce major errors in the following order of magnitude calculations. The assumption of complete stability is least justified because high-frequency oscillations are observed on the magnetic probe signals, and something must be causing the high electron energy losses.) The discharge is assumed to be in equilibrium in the radial direction, and the only motions considered, other than thermal motion, are in the direction of the main gas current. If v_e, v_d and v_0 are the mean velocities of the electrons, deuterons and O V ions respectively in this direction, and if a steady state is assumed, the following mobility equations hold for the O V ions and deuterons respectively:

$$4Ee + f_{e0}\, m(v_e - v_0) + f_{d0}\, M_d(v_d - v_0) + \sum_i f_{i0}\, M_i(v_i - v_0) = 0 \quad (1)$$

$$Ee + f_{ed}\, m(v_e - v_d) + \sum_i f_{id}\, M_i(v_i - v_d) = 0 \quad (2)$$

E is the component of the electric field in the direction of the gas current, m and M_d are the masses of the electron and deuteron, and f_{xy} is the collision frequency for momentum transfer for ions of type x colliding with a single ion of type y. The symbol i refers to an impurity ion, and the summation must be made over all types of impurity ion present, but with the omission of O V ions in equation (1). The loss of momentum by the particles to the walls has been neglected (see below). The gas current is given by:

$$I = N_d e\,(v_d - v_e) + \sum_i N_i Z_i e\,(v_i - v_e) \quad (3)$$

where N_i is the number of ions of type i per unit length of the discharge and $Z_i e$ the charge on such an ion.

That the terms due to impurities are of significance in equations (1)–(3) is suggested by the intensity of impurity spectral lines and also by the fact that without impurity terms, equations (2) and (3) yield a value for T_e (from f_{ed}) of 9×10^4 deg. K., whereas the measured temperature was $2{\cdot}5 \times 10^5$ deg. K.[8]. (T_e was obtained from the relation $f_{ed} = n_d e^2 \eta_\perp / m$, where the resistivity $\eta_\perp$ is given by Spitzer[12a].) The presence of the impurity terms makes it impossible to solve the equations because the densities and velocities of the various impurities are unknown. It is possible, however, to form general conclusions concerning the velocity v_d.

In order to do this, the impurity terms containing i are at first neglected in the three equations. Using the experimental results for two of the cases reported by Hughes and Kaufman (preceding communication), the values of f_{ed} have been calculated from equations (2) and (3) and then v_d and v_e from (1) and (3). The value of f_{e0} was obtained from the relation:

$$\frac{f_{e0}}{f_{ed}} = \frac{Z_0^3}{Z_d^3} = 16 \quad (4)$$

The quantity f_{d_0} was calculated using the expression given by Spitzer[12b], with T_d assumed equal to T_0 (see below) and taking $n_d = N_d/\pi a^2$, where a is the observed radius of the discharge from magnetic probe measurements (Table 1) and N_d the number of deuterium atoms present initially in the discharge per unit length.

The results in Table 1 give values of v_d greater than v_0 and approximately equal to $-v_e$. That v_d should, in general, be greater than v_0 can be seen from the fact that f_{e0} is 16 times greater than f_{ed}, whereas the electric force on the O V particles is only four times greater. Hence the electric field should cause the deuterons to have a larger drift velocity with respect to the electrons than the drift velocity of the O V particles, so that $v_d > v_0$. The deuteron – O V collision term acts merely to reduce the magnitude of the difference between v_d and v_0.

Considering now the effect of the impurity terms, in general the ratio f_{i0}/f_{id} will not be 16, because the average relative velocities between colliding particles will not be the same for the two types of collisions as

was the case in equation (4). However, provided that:

$$\frac{T_d}{T_e} > \left(\frac{16\,M_d}{Z_0^4 M_0}\right)^{1/3} \simeq 0{\cdot}2$$

f_{i0}/f_{id} will always exceed 4, and the electric field will cause the deuterons to have a larger drift velocity with respect to the i-particles than that of the O V ions and again $v_d > v_0$. The inclusion of the impurity terms in equations (1) to (3) plus the fact that a higher electron temperature must be taken to satisfy equation (2) leads to values for v_d closer to v_0 than those in Table 1. Thus for the given experimental conditions the theoretical model predicts that v_d lies in the range $v_0 < v_d < (v_d - v_e)/2$.

Using the velocities from Table 1, the net momentum of the gas per unit length of the discharge is approximately $NM_d v_d$, neglecting the contribution due to impurity ions. This is of the order of 1 dyne sec. cm.$^{-1}$. The momentum received by the electrons per unit length of the discharge during the time to reach peak current ($t \simeq 300$ μsec.) is of the order $-2N_d Eet/\pi$, which is about -50 dyne sec. cm.$^{-1}$. Hence the large ion velocities are explained if the electrons lose to the walls about 2 per cent of the momentum that they gain from the electric field. The simplest explanation of this momentum loss is that there is an appreciable electron particle loss to the walls. As already mentioned above, Colgate has obtained evidence for such a loss in his experiment. In the case of Sceptre III, if it is assumed that the momentum loss is carried by electrons in this way, the losses of momentum and energy can be reconciled, provided the mean energy of the electrons reaching the wall is less than 2 keV.

The Positive Ion Heating Mechanism

A significant feature of the above estimates of v_d is that the positive ions are carrying an abnormally high fraction of the gas current; the fraction is somewhere in the range 6–50 per cent. (If there were no losses from the discharge, the electrons and deuterons would have equal and opposite momenta, and the deuterons would carry only 0·03 per cent of the current.) Thus, the positive ions will receive a substantial fraction of the energy input directly from the electric field. The energy is converted to thermal energy as a result of particle collisions, and if collisions with electrons are the main resistance to the positive drift velocity then most of the energy will be transferred to thermal energy of the electrons because of the low electron mass. If, however, the dominant collisions are those with impurity ions, that is, if the sum of the terms containing f_{id} in equation (2) exceeds the term containing f_{ed}, the deuterons will retain most of the energy, since the impurity ions have masses large compared with the deuteron mass.

Assuming the latter to be the case and neglecting cooling processes for the deuterons other than by collisions with electrons, the deuterium temperature is given by:

$$Eev_d = \frac{3}{2}k\left(\frac{T_d - T_e}{t_{ed}}\right) \qquad (5)$$

where t_{ed} is the relaxation time for energy exchange and is given by Spitzer[12c]. Using the two limits obtained above for v_d, the deuterium temperature should lie in the range 8×10^5 to $1{\cdot}7 \times 10^6$ deg. K. for the 500 gauss case and 6×10^5 to $2{\cdot}8 \times 10^6$ deg. K. for 1,000 gauss. In the case of the O V ions, in order that these ions should retain most of the energy they receive from the electric field, the impurity ions must be the main resistance to the O V motion and most of the ions must have masses greater than that of oxygen. (Copper and aluminium have strong lines in the spectra.) In such a case the equation for the O V particles corresponding to equation (5) predicts values of T_0 of $1{\cdot}3 \times 10^6$ and $1{\cdot}0 \times 10^6$ deg. K. for 500 and 1,000 gauss respectively. In any event, at the temperatures involved here the rate of exchange of energy between deuterons and O V ions is about twice as rapid per unit temperature difference as that between O V and electrons. Hence, in general T_0 would be nearer to T_d than to T_e. Thus the theory predicts positive ion temperatures close to those indicated by the Doppler broadening (T. P. Hughes and S. Kaufman, preceding communication).

Conclusions

A simple model has been taken for the discharge in Sceptre III, and on this basis it has been deduced that the deuterons should have a mean velocity somewhat greater than that observed for the O V ions. The appreciable gas momentum involved is consistent with the electrons losing to the walls a small percentage of the momentum they receive from the electric field.

The discrepancy between the electron temperature calculated from the resistivity of the gas and that measured spectroscopically suggests that impurity ions may play a major part in scattering the deuterons. If this is so, the deuterons will retain most of the energy they receive from the electric field, and positive ion temperatures of the order of magnitude indicated by Doppler broadening for O V are to be expected. The theory thus shows that there is a simple and consistent explanation of the Doppler broadening on the basis that thermal motion is the cause. Because of the simplifying assumptions which have been made, however, the theory cannot be regarded as a proof of the existence of such temperatures.

I wish to acknowledge many helpful discussions with Mr. B. S. Liley and other colleagues at the Associated Electrical Industries Research Laboratory and with members of the Thermonuclear Division at the Atomic Energy Research Establishment, Harwell. The work reported here has been done under contract to the Atomic Energy Research Establishment, and I am grateful to Dr. T. E. Allibone, director of the Research Laboratory, Associated Electrical Industries, Ltd., for his continued encouragement and permission to publish this communication.

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ELECTRONIC COMPUTERS IN THE SERVICE OF BUSINESS

AT a distance of some days, it is possible to unscramble the many and varied impressions created at the Electronic Computer Exhibition and Business Computer Symposium (Olympia, London, November 28–December 4), and to consider what one feels are the more important implications. One may put aside such technical developments as the increasing use of printed circuits in place of wiring and of transistors in place of thermionic valves: such matters are applicable to the electronics industry as a whole. One may also disregard a number of technically interesting but somewhat irrelevant demonstrations, and the bread-and-butter exhibits of stationery, furniture and office equipment. It then becomes apparent that the most prominent feature of the Exhibition and Symposium was the emergence, in parallel, of a classic approach to the introduction of integrated electronic data-processing for business purposes, and of a fashion in the design of computer systems directed to cater for this approach.

That business has now taken over from scientific research the role of principal instigator of the development of computers can be clearly inferred not only from the types of computer system on show, but also and more directly from the fact that the majority of displays were of computer systems rather than of simple computers. The predominant trend in design is towards what Lord Halsbury in his opening address to the Symposium described as the "fully literate computer": one which is designed to read information from the widest possible range of input media (manual keyboard, punched paper tape, punched cards and magnetic tape), and can write information on an equivalent range of output equipment; one which, moreover, can grant a considerable measure of autonomous control to its input and output facilities so that these may proceed independently, transferring information to or from buffer storage in readiness for the central computer's demands. Such a trend must be to the gratification of one manufacturing organization, at least, which was operating electronic data-processing equipment on something approaching this basis at a time, four years ago, when no other general business electronic data-processing installation existed.

In an attempt tp keep up with this trend, some small and medium-sized computers have followed the tactics of the puffer fish. Though thoroughly competent in the role for which they were originally designed, these machines are being required to support a burden of peripheral equipment out of all proportion to their normal capacity. Prospective purchasers may well consider whether there can be any justification for tying upwards of £100,000 worth of input, output and ancillary storage equipment to the apron strings of a computer which is incapable of utilizing effectively more than a small proportion of its potential activity. It was equally regrettable to note the manner in which one or two exhibitors sought to attract attention by stunts which had little or no connexion with the intended application of their equipment. "Good wine needs no bush", and an effective computer does not require a 'gimmick'.

In respect of ancillary equipment, one could discern another important trend. While mechanical equipment is being pushed to the utmost to achieve greater speeds of printing, punching and hole sensing, in one corner of the exhibition could be seen the all-electronic writing on the wall. A prototype printing device was on show in which the characters, delineated by deflexions of the beam of a cathode-ray tube in response to signals decoded from a magnetic tape, are used, by means of a system of optical projection and static charges, to deposit powder in appropriate shapes upon a continuously moving roll of paper. The powder is then bonded to the paper by heat treatment, emerging as a succession of lines of print to be taken upon an output roller. The speed of output by this equipment is of the order of ten times that of the most rapid mechanical line printer on show, yet the only moving parts are the slowly revolving rollers. Elsewhere could be seen prototype equipment which, by use of cathode-ray tube scanning and photo-multipliers, could, in a continuous process, read typescript characters from a document and code these in computer language on to magnetic tape. Such equipment, when perfected, will have two great advantages. High-speed mechanical equipment, particularly when reciprocating motion is involved, is not infrequently subject to mechanical breakdown. In order to avoid interrupting the flow of work while spare parts are obtained and repairs are made, it has become common practice to install an expensive spare machine which will be idle for a considerable part of the time. Moreover, the direct automatic conversion from original document to computer language and from the latter to printed output will eliminate the intermediate steps in which human errors are likely to be introduced.

The classic approach to an integrated electronic data-processing system was apparent in a well-developed form in three of the papers presented at the Symposium, and in an embryonic state in at least three more. It reflects the growing confidence of business management in the feasibility of such a system, as exemplified by the comment of one speaker that if his system of completely integrated data-processing did not prove satisfactory he would be obliged to seek a new occupation. This attitude is a far cry from the somewhat timid and tentative approaches to electronic data processing of some applications represented at the Symposium but not representative of it. The classic approach involves a penetrating research into the very fundamentals of the existing business system, questioning why the various functions are performed, rather than investigating the exact manner of their performance. It is essential, of course, that such an investigation should be carried out under the close direction of persons of managerial or senior supervisory calibre. Many speakers at the Symposium were agreed that it was equally necessary that the 'organization and methods' personnel concerned in investigations for an electronic data-processing system should have a sound general knowledge of programming techniques and that programmers should be acquainted with 'organization and methods' procedure. The two can then work in close collaboration to determine the nature of the

original information available for input and that of the various types of output information which should be proved necessary or desirable. From this they would devise an efficient system for achieving the requirements, using the full range of equipment available. Carried to its logical conclusion, such an investigation should not consider the somewhat arbitrary divisions into which a business may be divided at present (for example, wages and salaries, cost accountancy, production and stock control, sales invoicing), but should include the whole scope of the business. This may sound a Utopian concept, but it is already being attempted by some, and is considered the essential goal by many others.

The essential element of such an approach is the open mind, uninhibited by existing manual or punched-card clerical systems. Some business organizations which have not yet installed mechanized systems of any kind have considered adopting a little-by-little approach; a gradual transition by introducing first a punched-card system, then a small-scale computer, and finally a fully developed large-scale computer system. To these the experience of one business organization may be of interest and provide some guidance. The spokesman of this concern explained that the computer system now being installed bears very little resemblance to the punched-card system which preceded it, although he acknowledged that the latter had provided some useful experience in planning.

It is true that the applications of a limited scope may sometimes be of outstanding importance. A saving of the order of £50,000 per annum for the expenditure of three or four hundred pounds was reported at the Symposium from the application of linear programming techniques to a problem of bulk transportation, and an account was given of how an hour or so a week on a small computer had made possible the introduction of a greatly improved method of production control. But in general, the most substantial benefits will come from a comprehensive system. This does not imply that an integrated system can be installed in one operation. The system must be planned with the view of dividing it into phases which are of such a size and nature that they may be introduced in sequence over a period of many months. The transition, indeed, requires some of the most careful and detailed planning, for each phase must be introduced with the least possible disturbance both to work already on the computer and to procedures which are still carried out manually. It is normally advisable to run each new phase on the computer in parallel with the previous system until it is reasonably certain that all eventualities have been covered. Furthermore, it is prudent to prepare in advance an emergency procedure for adoption in the event of a serious breakdown of the equipment, however unlikely this may be.

Compared with strategical planning of such complexity, the tactical programming may well prove relatively simple. However, just as interpretive routines and automatic coding techniques permit the computer to assist the programmer, so may some of the computer techniques which are being developed in the field of operational research be of assistance to the planner. A paper on developments in this field was presented at the Symposium, and the speaker agreed with a suggestion that the simulation techniques which he had described could be used to study the feasibility of systems designed for a business electronic data-processing installation. A large organization might find it worth while to acquire a small computer initially for this purpose. If this machine were compatible with the peripheral equipment of the proposed large installation, it could later be used in conjunction with it, and would prove invaluable for carrying out those housekeeping activities such as sorting and merging which occupy so much of the time of a large computer while exploiting so little of its capabilities. This, then, may represent the pattern for the future use of electronic computers in business.

In conclusion, I wish to make it plain that the opinions expressed above are of a purely personal nature, and should not be construed as representing the policy of the organization with which I am associated.

W. L. C. Garrett

SCIENTIFIC CENTENARIES OF 1959

By JOAN M. EYLES

One of the first requisites for the traveller is a good map of the country in which he proposes to travel. If none exists, then his travels will help to provide one. The launching of the First Crusade in 1095 by Pope Urban II marked the beginning of a series of mass pilgrimages across Europe which continued for nearly two centuries and must have given rise to a demand for maps, guides and charts to help the traveller on his way. The earliest medieval maps of Britain are those made by Matthew Paris, the great historian. Matthew, a Benedictine monk of the Abbey of St. Albans, died seven hundred years ago, in 1259, and his maps of Britain are believed to date from 1250. Their main object was probably to show the towns and monastic guest-houses where the pilgrim could rest on his way to Dover, the usual point of departure for the Holy Land. Many of the legends on the maps are of interest; Snowdon is both named and shown by an outline of a mountain, a convention that survived on maps until the middle of the eighteenth century, when hachuring came into use. Other maps prepared by Matthew Paris which still exist include one showing the route from London to southern Italy.

When William Harvey described the circulation of the blood in his "De Motu Cordis" (1628), he referred to the Italian anatomist, Matteo Realdo Colombo, who died in 1559, and whose work, "De Re Anatomica", appeared shortly after his death. Colombo, a pupil of Vesalius, made a close study of the blood vessels of the lungs and discovered experimentally the pulmonary circulation, although he did not understand or recognize the general circulation. Colombo was appointed successor to Vesalius at Padua in 1545, but went to Pisa in the following year and taught there. Later he moved to Rome, where he was teaching when he died.

Two authors of arithmetic books died in 1559. One was Cuthbert Tunstall, Bishop of London and friend of Sir Thomas More, whose "De Arte Supputandi", written in Latin and first printed in 1522, was the earliest arithmetic by an English author. The other was Adam Riese, born in Bavaria in 1489, who wrote a popular arithmetic and a treatise on practical geometry. His arithmetic was so widely used that "Nach Adam Riese" can be looked on as equivalent to the English expression "according to Cocker".

Among the bicentenaries of the year, that of the French scientist, P. L. M. de Maupertuis, who died on July 27, 1759, is particularly interesting. De Maupertuis was leader of the French expedition to Lapland in 1736 to measure the length of a degree of longitude, achieving results which verified Newton's theory that the Earth was an oblate spheroid. He became president of the Royal Academy of Sciences in Berlin, and was afterwards involved in a bitter controversy with Voltaire. It is worth recording that he also had ideas about evolution and made an early attempt to explain the origin of new species.

Jacob T. Klein, born in Königsberg in 1685, and author of several zoological works, also died in 1759. Klein visited England in the course of his travels, and in 1728 was elected a Fellow of the Royal Society.

A significant event of 1759 was the establishment of a botanic garden in the grounds of Kew House, on the instructions of Augusta, Dowager Princess of Wales and mother of George III. Some thirty years later, Erasmus Darwin wrote :

> "So sits enthron'd in vegetable pride
> Imperial Kew by Thames's glittering side ;
> Obedient sails from realms unfurrow'd bring
> For her the unnam'd progeny of spring ;"

From these beginnings arose the magnificent Royal Botanic Gardens at Kew which we know to-day.

Several well-known naturalists were born in 1759. In particular, we note Sir James Edward Smith (1759–1828), founder and president for forty years of the Linnean Society of London. The story of how the young botanist was breakfasting with Sir Joseph Banks and seized the opportunity of purchasing the collections of Linnæus has often been related. This memorable purchase was followed by several years travel in Europe, and on his return Smith founded the Linnean Society. This was not the first Society started by Smith, for some years before, when a student at Edinburgh, he and a few friends with similar interests had formed a Society for the pursuit of natural history, which was attended by men as prominent as Black the chemist and Hope the botanist.

Born on August 12, 1759, a few months before Smith, Thomas Andrew Knight, a country gentleman, also became known as a botanist and founder of a Society. Knight was another member of the Banks circle, and one of Sir Joseph's many correspondents. He became a Fellow of the Royal Society in 1805 and in the following year received the Copley Medal for his investigation of tropisms in plants. He also carried out extensive researches into the improvement of fruit trees by crossing. One of the founders of the Horticultural Society, he became its second president in 1810, a position he occupied until his death in 1838.

Another enthusiastic naturalist was the Rev. William Kirby, rector of Barham in Suffolk, whose name appears on the first list of Fellows of the Linnean Society. Kirby's chief interest was in entomology, and he is remembered as joint author with Spence of a popular introduction to entomology.

Three French naturalists born in 1759 were L. A. G. Bosc, who travelled extensively in North America, J. B. Audebert, artist and author of several beautifully illustrated books, including "L'Histoire Naturelle des Singes", and P. J. Redouté, the famous flower painter.

An interesting chemical anniversary is that of the birth of Thomas Cooper, free-thinker and student of the natural sciences, who emigrated to America in 1793. He was a close friend of Priestley, who bequeathed to him his chemical apparatus, including the historic burning glass used in the discovery of oxygen. Cooper taught chemistry and mineralogy in the United States for many years, first in Pennsylvania, then in Virginia, and later in South Carolina. His advanced thinking and love of free speech, which had led to his leaving England, brought him into further trouble in America, and in 1833, after writing to Silliman that "the Old as well as the New Testaments were by no means infallible guides in mineralogy and geology", he was forced to resign his position as president of the College of South Carolina. Cooper did much to spread the knowledge of the new chemistry of Lavoisier in the United States, and edited a number of chemistry text-books ; but he was an unorthodox character, whom an English geologist described as "a most remarkable man some of whose screws were uncommonly loose".

The first practical demonstration of aerostation in England was made by Vincenzo Lunardi (1759–1806), a daring young Italian diplomat, who ascended in a balloon from Moorfields, London, on September 15, 1784. He travelled some twenty-four miles in two and a quarter hours, touching down at North Mimms on the way to land his cat, which was suffering from the cold. This aerial voyage was watched by thousands of people, including the Prince of Wales and prominent politicians.

Passing to 1859, undoubtedly the most eminent of the scientists who died in that year was Alexander, Baron von Humboldt. Born in Berlin in 1769, he studied first at Göttingen and later at the School of Mines at Freiberg. On leaving the latter he received an appointment in Berlin as superintendent of mines. For four years he carried out his duties, visiting mines and studying geology. In 1796 he gave up his post and devoted himself to further scientific studies in order to prepare himself for travel. After several disappointments, in 1799 he set sail for South America with the botanist Aimé Bonpland, having obtained special permission from the King of Spain to travel in and examine Spanish territories in the New World. It was five years before he returned to Europe, having travelled some 40,000 miles, bringing back with him more than thirty cases of geological and botanical specimens. During 1808–27 he made his home in Paris, which he regarded as the centre of the scientific world, and devoted himself to preparing detailed accounts of his travels and the collections he had made. In 1827 he moved to Berlin, and he remained in Germany until his death in 1859. He had hoped to travel in Asia as extensively as he had in America, but the realization of his hopes was limited to a nine-months journey across Russia and Siberia in 1829.

Humboldt made many contributions to science, in the fields of geology, geography and climatology, but he is also remembered for the inspiration he was

to others, and in particular to Charles Darwin. The latter wrote in 1845: "I never forget that my whole course of life is due to having read and re-read as a youth his 'Personal Narrative' ". A. R. Wallace, too, wrote of the influence this book had upon him. When Humboldt died, on May 6, 1859, he was within six months of his ninetieth birthday, and ten years later the centenary of his birth was celebrated with enthusiasm on both sides of the Atlantic.

Karl Ritter, the geographer, who also derived inspiration from Humboldt's writings, died only a few months later, in September 1859. Ritter did much to establish the science of comparative geography, and endeavoured to show that the physiography of a country had a direct influence on the life and progress of the nation inhabiting it.

Another scientific traveller who spent many years in the United States was Thomas Nuttall (1786–1859), a Yorkshire printer who emigrated in 1807. He was persuaded to take up botanical studies, and underwent many hardships during his solitary travels in the interior of the United States in search of specimens. He is said to have discovered an almost unequalled number of new genera and species. During 1825–34 he was curator of the botanic gardens at Harvard, but in 1841 returned to England to occupy a family estate at Nutgrove, near Liverpool, where he cultivated many rare plants. He died on September 10, 1859, and his herbarium of more than 5,000 species was purchased by the British Museum.

The British Museum also acquired the herbarium of Javanese plants belonging to Thomas Horsfield (1773–1859), a Pennsylvanian-born physician who practised in Java and Sumatra from 1799 until 1819, when he became keeper of the East India Company's Museum in London. Yet another botanist who died in 1859 was K. A. Agardh, born in Sweden, who published the first general account of diatoms. His "Systema Algarum" (1824) entitles him to be regarded as a pioneer in the classification of the algae.

In the field of geology, Denison Olmsted (1791–1859), a Yale graduate who became professor of chemistry, mineralogy and geology at the University of North Carolina, was one of the first to appreciate the value of a State geological survey. He laid a plan for one before the State legislature in 1821, and an Act authorizing such a survey was passed two years later. Olmsted received no fees, but expenses of 250 dollars a year. His preliminary reports were published in 1824 and 1825. He was then recalled to Yale as professor of mathematics and natural philosophy. Later he became professor of astronomy at Yale, and observed the return of Halley's comet in 1835, making the announcement long before confirmation arrived from Europe.

Four years after this event, Harvard decided to establish an observatory, and William Cranch Bond (1789–1859) was appointed 'observer', later becoming its first director. Bond was an instrument-maker in Boston with a taste for astronomy, who had constructed his own instruments and built an observatory at his home. When he died in 1859, he was succeeded at Harvard by his son, George Phillips Bond.

Three mathematicians of some note also died in 1859. The most senior, Louis Poinsot, was born in Paris in 1777. He was particularly interested in statics, but published a number of works on geometrical and mechanical subjects. The theory of couples is largely due to him, also that of the motion of a body in space under the action of no forces. J. L. Raabe, of Zurich, born in 1801, chose higher algebra for his field of research, and discussed the convergency of series; while Peter Lejeune Dirichlet, born at Duren in 1805, became a pupil of Gauss, and succeeded him at Göttingen in 1855. He is best known as an interpreter of Gauss and of Jacobi, his father-in-law, but is also remembered for having introduced into the calculus of variations the so-called Dirichlet principle.

The tubular girder railway bridge spanning the Menai Strait in North Wales and the High Level bridge across the Tyne at Newcastle both stand as memorials to the famous engineer, Robert Stephenson, son of an equally famous father. Stephenson died in October 1859, and was buried in Westminster Abbey.

Passing on to more recent times, and the centenaries of scientists who were born in 1859, we note first two who were awarded Nobel Prizes, Pierre Curie and Svante Arrhenius. Pierre Curie, born in Paris on May 15, 1859, married the young Polish chemist, Marja Sklodowska, in 1895. Six months later Röntgen discovered X-rays, and so began that well-known chapter of scientific history in which is recorded the Curies' joint investigation of the radioactive elements. Pierre had already studied the behaviour of crystals in electromagnetic fields, and had discovered the piezo-electric effect. To the joint research he brought a familiarity with delicate electrical instruments which proved of great value in determining the physical properties of the newly discovered elements. In 1903, the announcement by Pierre Curie and his pupil, Laborde, that radium emits heat rendered valueless Kelvin's estimate of the age of the Earth, based on its rate of cooling, and paved the way for an entirely new method of estimation, based on radioactivity.

In the same year, the Curies and H. Becquerel shared the Nobel Prize for Physics. Three years later, a street accident brought a tragic end to Pierre's life, though, as all know, the work on radioactivity was carried on valiantly by his widow, who herself received the Nobel Prize for Chemistry in 1911.

While Pierre Curie was studying the passage of electricity through crystals, Svante August Arrhenius, born near Uppsala on February 19, 1859, was investigating its passage through dilute solutions. His theory of electrolytic dissociation, first embodied in the dissertation for his doctorate in 1883 and published in full in 1887, received more support abroad, particularly from Ostwald and Van 't Hoff, than in Sweden. Recognition eventually came, and with it the Nobel Prize for Chemistry in 1903, and the establishment in 1909 of a Nobel Institute in Stockholm, which he directed until his death in 1927. His bold and original ideas were not confined to physical chemistry, but extended to the fields of serum therapy and cosmology, volcanism and the cause of glacial periods. Appreciation of his work was shown in British scientific circles by the conferment of foreign membership of the Royal Society and of honorary degrees by the Universities of Oxford, Cambridge, Edinburgh and Birmingham.

Two men born in 1859 both occupied prominent positions at the Rockefeller Institute for Medical Research in New York. One was Jacques Loeb, biologist and biochemist, born at Mayen in Germany, who left his homeland for the United States in 1891. He spent ten years in Chicago, seventeen at Berkeley, and was then made head of the Division of General

Physiology in the Rockefeller Institute, a position which he held until his death in 1924. Founder of the modern school of physiology, his early experiments in artificial parthenogenesis startled the scientific world by producing the fatherless sea-urchin and the fatherless frog. He investigated the effects of various stimuli upon living matter, and followed this by extensive research on proteins. Although a brilliant experimentalist, his philosophical ideas, particularly as stated in his "Mechanistic Conception of Life", aroused considerable criticism and opposition.

Loeb's contemporary, Theobald Smith (1859–1934), of Albany, New York, occupies an honoured place in medical science for his pioneer work investigating the transmission of disease and immunization. Inspired by the work of Koch, in 1889 he discovered the parasite responsible for Texas fever in cattle, and in his classic report of 1893 gave the first account of the transmission of a parasitic protozoan by a blood-sucking parasite. Later, he clearly differentiated between the bovine and human types of tubercle bacilli. He was the first occupant of the chair of comparative pathology at Harvard, and was eventually appointed director of the Department of Animal Pathology in the Rockefeller Institute. He was elected a foreign member of the Royal Society in 1932.

Two well-known British geologists were born in 1859, namely, Alfred Harker and G. W. Lamplugh. Harker, while retaining his lectureship at Cambridge, was for ten years attached to the Scottish Geological Survey. This period was devoted to mapping the volcanic rocks of Skye and other islands of the Inner Hebrides, and his descriptions of these rocks became classics in geological literature. His later more general works on igneous rocks and metamorphism also exerted a lasting influence on petrological thought. He died in 1939, six months after the celebration of his eightieth birthday. G. W. Lamplugh had his first geological paper, on glacial drift in Yorkshire, published when he was only nineteen. He joined the Geological Survey in 1892, and during the next five years completed almost single-handed the mapping of the Isle of Man. Afterwards he carried out an extensive examination of the Irish glacial deposits. He retired from the Survey in 1920 and died six years later. Both Harker and Lamplugh were Fellows of the Royal Society and each had occupied the presidential chair of the Geological Society.

A rather controversial figure in the history of science is that of the Russian physicist, A. S. Popov (1859–1905), a pioneer in the field of radio telegraphy, whose success in signalling has been claimed as antedating that of Marconi. Others born in 1859 include the organic chemists, J. B. Cohen and L. Knorr, the American chemist H. Y. Castner, whose name is associated with the Castner–Kellner process for the manufacture of chlorine and the extraction of sodium, and Florian Cajori, historian of mathematics.

NEWS and VIEWS

Contributions to *Nature*

DURING the first year of the publication of *Nature* (November 1869–November 1870), the number of original communications (mainly "Letters to the Editor", together with some special articles, though not the general ones) was 378. These came from 17 different countries. In certain selected years afterwards, the number of original communications were as follows (number of countries in parenthesis): 1910, 285 (19); 1920, 422 (17); 1930, 568 (27); 1937, 648 (31); 1949, 1,066 (35). During last year (1958), the number of such communications was 2,362, and these were submitted from 59 different countries. These were distributed as follows:

Argentina	2	Japan	80
Australia	128	Kenya	13
Austria	2	Malaya	7
Belgian Congo	3	Mauritius	1
Belgium	41	Mexico	1
Brazil	6	New Zealand	53
British Borneo	1	Nigeria	9
British Honduras	1	Norway	14
British West Indies	11	Pakistan	2
Canada	67	Philippines	1
Ceylon	3	Poland	18
Chile	3	Portugal	1
China	1	Puerto Rico	1
Costa Rica	1	Roumania	5
Czechoslovakia	53	Sarawak	1
Denmark	14	Sierra Leone	3
Egypt	8	South Africa	37
Finland	4	Spain	7
Formosa	1	Sudan	2
France	16	Sweden	44
Germany	25	Switzerland	10
Ghana	4	Tanganyika	3
Greece	1	Uganda	18
Hawaii	5	United Kingdom	959
Holland	48	United States	407
Hungary	24	U.S.S.R. (Russia)	10
India	96	Venezuela	2
Indonesia	1	Yugoslavia	6
Ireland	18	*Total No. of countries*	*59*
Israel	19	*Total No. of communications*	*2,362*
Italy	40		

New Science Officers for American Embassies

SEVEN distinguished scientists have been appointed by the U.S. Department of State to serve as science officers in the American Embassies in London, Paris, Rome, Bonn, Stockholm, and Tokyo. Although assigned to a specific embassy, the science officer will also provide scientific assistance in embassies in adjacent areas. The men selected are: Dr. Thomas H. Osgood, dean of the School for Advanced Graduate Studies, Michigan State University, for London; Dr. Edgar L. Piret, professor of chemical engineering, University of Minnesota, for Paris; Dr. Edward H. Cox, retired head of the Department of Chemistry, Swarthmore College, as deputy science officer for Paris: Dr. Walter Ramberg, chief of the Mechanics Division, National Bureau of Standards, for Rome; Prof. Ludwig F. Audrieth, professor of chemistry, University of Illinois, for Bonn; Dr. Julian E. Mack, professor of physics, University of Wisconsin, for Stockholm; and Prof. Willis R. Boss, professor of zoology, Syracuse University, for Tokyo. The appointments, which will be for a period of two years, constitute the first of a series for the Science Programme of the Department of State under Dr. Wallace R. Brode, science adviser to the Secretary. Still to be appointed are science officers for the U.S.S.R., India and South America, and deputy science officers for all the posts with the exception of Paris, to which Dr. Cox is being assigned. Leaders in science who have had experience as educators, research workers and administrators have been especially selected for these posts because of their international scientific reputation, and their knowledge of the status of science and acquaintance with scientists in the country of assignment. Each of those appointed

also has a facility with the language of the country of assignment. A science officer's primary role will be to serve as an adviser to the Ambassador and his staff in the evaluation of the interaction of science with foreign policy, the assessment of current scientific progress abroad and the enhancement of the liaison between United States and foreign scientists and engineers.

British Scientific Attachés Overseas

Replying to a question in the House of Commons on December 8 regarding scientific attachés, Mr. G. M. Thomas, Parliamentary Secretary to the Ministry of Works, as representing the Lord President of the Council, said that the British Embassies at Washington, Paris, Bonn and Stockholm had a scientific attaché on their staff. The choice was now being made of a suitable person for scientific attaché to the British Embassy in Moscow and the appointment of scientific attachés to certain other embassies was under consideration.

Department of Scientific and Industrial Research: New Five-Year Plan

Mr. Harmar Nicholls, Parliamentary Secretary to the Ministry of Works, speaking on behalf of the Lord President of the Council, announced in the House of Commons on December 19 that expenditure on research by the Department of Scientific and Industrial Research will be nearly doubled in the next five years. Under its second five-year plan, for the period 1959–64, approximately £61 million will be made available to the Department, compared with £36 million for the first quinquennium which ends on March 31. By 1963–64 expenditure is planned to reach about £14 million, excluding the British contribution to the European Organization for Nuclear Research (C.E.R.N.) which will continue to be financed outside the five-year plan. The largest expansion will be in university grants. Postgraduate awards will be increased by about 10 per cent each year, until in 1963–64 some 3,800 students will be receiving grants from the Department for research, and support for special research in universities will amount to £1¼ million per annum.

In support of additional research carried out in the Department's own laboratories, expansion of staff at the rate of about 6 per cent per annum is included in the plan. Grants to the research associations financed jointly by the Department and industry will also be increased to more than £2 million per annum by the end of the period. It is also proposed that the Ministry of Works shall increase its rate of expenditure on behalf of the Department so as to provide buildings and equipment for the increased staff of its laboratories. The works programme includes the provision of a new laboratory at Crowthorne, Berkshire, to rehouse the Road Research Laboratory which at present occupies two separate sites a few miles apart, one at Harmondsworth, Middlesex, and the other at Langley, Bucks. The new Road Research Laboratory will include an experimental road system 3½ miles long.

Public Expenditure on Education

In written answers in the House of Commons on December 17, Mr. Geoffrey Lloyd, Minister of Education, said that expenditure by the Ministry and local education authorities, excluding capital expenditure, was expected to be about £46 million in the current year, rising to about £57 million in 1960–61. To give maximum maintenance grants to 50,000 additional pupils of sixteen and seventeen at the approved rates would cost about £16 million a year. To reduce all classes to a maximum of thirty by about 1965 would cost about a further £200 million a year, with some £140 million on training additional teachers.

Exchange of Personnel between the Post Office and Industry

On December 17, the Postmaster-General, Mr. H. Marples, in reply to a question in the House of Commons, said that on January 5, a Post Office administrator and a Post Office engineer would take up temporary appointments with Unilever, Ltd., and two Unilever men would go to the Post Office. The exchange was expected to last about a year, and discussions with another concern were in progress. He hoped the experiment would be a forerunner of a regular interchange of experience between the Post Office and industry and contribute mutual benefit and a better understanding of each others' problems.

Pharmacology at the Royal College of Surgeons

The Royal College of Surgeons of England has received a gift of £150,000 from Mr. G. A. Vandervell for the endowment of its chair of pharmacology. More than ten years have elapsed since those responsible for the rehabilitation of the College after the Second World War recognized that a Department of Pharmacology should be added to the existing departments of anatomy, pathology and physiology, for without it the education of postgraduates in the basic medical sciences would have been incomplete. A still more important objective, however, was the promotion of research into the action of drugs and other substances used not only by surgeons but also by dentists and anæsthetists, who are represented by faculties within the College. The Department was therefore established six years ago, and has flourished under the able direction of Prof. W. D. M. Paton, whose researches into the chemical mediation of nerve impulses are so well known. He and his assistants have been housed temporarily at the Examination Hall, Queen Square, but will shortly be moving into the new buildings in Lincoln's Inn Fields. Since the College is an independent body and therefore does not receive a direct grant from the University Grants Committee or from any other Government source, the Department has been financed hitherto partly by generous contributions from the chemical and pharmaceutical industries. This donation from Mr. Vandervell, which will endow the chair in perpetuity, is doubly welcome since it comes at a time when the College is facing heavy increases in expenditure owing to the extension of its research activities.

National Lending Library for Science and Technology

The Department of Scientific and Industrial Research will take over part of the former Royal Ordnance Factory at Thorp Arch, near Boston Spa, Yorks, for the use of the new National Lending Library for Science and Technology. Present proposals indicate that the library will begin operating at Thorp Arch in 1961 and become fully operational during the following year. Existing large single-story

buildings will be converted into offices and bookstores, and the site provides adequate room for expansion in the future. The new library—the nucleus of which already exists in the Department's Lending Library Unit now at Chester Terrace, Regent's Park, London—will cover all subjects in science and technology, except for some fields of medicine. It will take over the responsibility for the lending service now provided by the Science Museum Library, which in future will concentrate on serving the needs of the enlarged Imperial College of Science and Technology. It is also taking over some of the literature now held by the Science Museum Library. The present Lending Library Unit has been collecting literature for the National Library since 1957. It already operates a loan service for Russian literature which is being progressively extended to cover publications from other countries. Eventually, much of the scientific and technological literature in the world will be included in this collection, to make it the most comprehensive of its kind in the United Kingdom. The new library in Yorkshire will make its unique collection available to research, industrial, educational and other organizations by loans and photographic reproduction. Its primary objective will be to encourage the greater use of scientific and technical literature. One important activity will be the expansion of work on the translation of Russian scientific literature, now organized by the Lending Library Unit in collaboration with the National Science Foundation in the United States. It remains distinct from the National Reference Library of Science and Invention, which it is proposed to establish in London as the successor to the existing Patent Office Library.

International Federation of Operational Research Societies

An International Federation of Operational Research Societies has been created with the objects of developing operational research as a unified science and its advancement in all countries. The initial membership of the Federation consists of the Operational Research Society (United Kingdom), the Operations Research Society of America, and the Société Française de Recherche Opérationnelle. Membership is open to other national societies with the primary object of promoting operational research and with memberships including qualified scientists working in this field. The Federation will be governed by a board of representatives, one representative coming from each member society. According to the statutes, the voting power of each is proportional to the square root of the size of the membership of the Society he represents.

One of the first activities of the Federation will be to sponsor the second international conference on this subject, following the successful first conference held in Oxford in 1957. The second conference is provisionally planned to be held at Aix-en-Provence early in September 1960. Sir Charles Goodeve has agreed to act as secretary and Mr. Donald Hicks as treasurer of the Federation, the address of which is 11 Park Lane, London, W.1.

American Geographical Society Expedition to Chile

The American Geographical Society is sending an expedition to southern Chile for two months study of glaciers in the vicinity of Laguna de San Rafael. Dr. Calvin J. Heusser, of the Society's research staff, will be in charge of the project, which is supported by the Office of Naval Research. Its purpose is to determine the nature and duration of successive phases of climate and vegetation since the glaciers of the last Ice Age receded. The Laguna de San Rafael area was selected because it contains the northernmost glaciers in South America reaching to sea-level and also because its climate, vegetation and physical features resemble those of south-eastern Alaska, where the Society has conducted similar studies since 1948. By correlating the results from Chile with those from Alaska it is hoped that a comparative chronology of climatic variations in the northern and southern hemispheres may be obtained. In addition to Dr. Heusser, the expedition comprises Dr. and Mrs. D. B. Lawrence, both professors of botany in the University of Minnesota; Dr. E. H. Muller, professor of geology, Cornell University; Dr. Carlos Munoz Pizarro, of the Faculty of Agronomy, University of Chile; Shoji Horie, of the Department of Botany, Yale University; and Augusto Grosse, of Puerto Aysen, Chile.

The Atlas Satellite (1958 ζ)

The largest and heaviest satellite so far placed in orbit by the United States was launched in a south-easterly direction from Cape Canaveral in Florida at 23.02 U.T. on December 18. The complete satellite weighs some 8,500 lb., of which only a small proportion, about 150 lb., is pay-load. The remainder of the object is the empty shell of the *Atlas* missile which performed the launching, about 80 ft. long and 10 ft. in diameter. The main purpose of the satellite is to act as a radio relay station, storing and re-transmitting, on frequencies of 132·45 and 139·905 Mc./s., messages sent to it from the ground. It also carries telemetry transmitters operating on 107·97 and 107·94 Mc./s. The satellite is the first to be successfully launched since July 1958, and is designated 1958 ζ. Its orbit is inclined at 32·4° to the equator. Initially, the period of revolution was 101·47 min., and the height varied between 120 and 920 miles, an eccentricity of 0·089; the perigee was near lat. 25° N., when the satellite was on the southward half of its orbit, but the perigee point moved rapidly forward around the orbit, at a rate of 8½° a day. Because its perigee is so low, the life-time of the satellite is expected to be short—only about four weeks.

Giacomo Pylarino (1659–1718)

A pioneer who made variolation a scientific procedure, Giacomo Pylarino was born 300 years ago on January 9, 1659, on the Ionian island Cephalonia. He studied law at Venice and medicine at Padua where he graduated M.D. Practising at Candia in Crete, he made enough money to allow him to travel, and he visited Constantinople, Syria, Egypt, and Smyrna, where he became Consul for Venice. In 1713, Emmanual Timoni, a Greek physician of Constantinople, wrote for the *Philosophical Transactions* an account of the method of variolation as observed and practised by him. Anxious to have further details, Sir Hans Sloane wrote to the British Consul at Smyrna, Dr. Sherrard, who communicated with his former colleague, the Venetian Consul. Pylarino had returned to Venice, but was persuaded to draw up an account of what he knew of the original methods of inoculation at Constantinople during the first years of the century. This was printed at Venice

in 1715 under the title "Nova et tuta variolas excitandi per transplantationem methodus; nuper inventa et in usum tracta" and at once copied into the *Philosophical Transactions*. "The most trustworthy account of the Constantinople practice" (Charles Creighton), it dates back to 1701, in which year Pylarino inoculated three children with smallpox virus. He had learned the technique from a Greek woman, but dropped the symbolism, using the skin of the forearm instead of the face at the four points touched in making the sign of the Cross and at the points of the hands and feet pierced by the nails in the Crucifix. It is interesting to note that he spoke of "transplantation" and Timoni of "inoculation"—both figures of speech taken from the gardener's art. Following the publication of Pylarino's description, the Royal Society became really interested in inoculation, and the pages of the *Philosophical Transactions* were filled with further accounts. These were regarded as "virtuoso amusements" (William Douglass) until 1721 when inoculation began to be tried tentatively in London. Pylarino was then no longer living, having died at Padua in June 1718.

City Literary Institute: Science Lectures

A new series of lectures sponsored by the City Literary Institute, Stukeley Street, London, W.C.2, and under the auspices of the University of London Department of Extra-Mural Studies, under the general title "Tools of Scientific Discovery: A Review for the Layman and Non-specialist", will begin on January 6, when Prof. G. O. Jones will give an introductory lecture. The other lectures are as follow: "Low Temperatures", Prof. G. O. Jones (January 13); "Radio Telescopes", Mr. Martin Ryle (January 20); "High Temperatures", Dr. R. Latham (January 27); "X-Rays", Dr. H. Judith Milledge (February 3); "Accelerators", Prof. J. Rotblat (February 10); "Isotopes", Prof. J. Rotblat (February 17); "Rockets", Prof. H. S. W. Massey (February 24); "Computers", Dr. R. A. Buckingham (March 3); "Television Techniques", Prof. J. D. McGee (March 10); "Electron Microscope", Mr. C. D. Curling (March 17). The fee for the course is 8*s*. Further information can be obtained from the Principal of the Institute.

The Night Sky in January

New moon occurs on Jan. 9d. 05h. 34m. U.T., and full moon on Jan. 24d. 19h. 32m. The following conjunctions with the Moon take place: Jan. 5d. 11h., Jupiter 2° S.; Jan. 18d. 23h., Mars 5° N. In addition to these conjunctions with the Moon, Mercury is in conjunction with Saturn on Jan. 11d. 04h., Mercury being 0·7° S. Mercury is too close to the Sun for easy observation. Venus is an evening star, visible low in the south-west for a short time after sunset. It sets at 18h. 25m. on January 31; its stellar magnitude is −3·3. Its distance decreases during the month from 170 to 159 million miles. Mars is moving eastwards among the stars and is in Aries throughout January. It sets at 3h. 55m., 3h. 20m. and 2h. 46m. at the beginning, middle and end of the month, respectively. Its stellar magnitude decreases from −0·6 to +0·3, its distance from the Earth increasing from 68 to 94 million miles. Mars is in an excellent position for observing during the evening. Jupiter rises at 4h. 25m., 3h. 40m. and 2h. 45m. on January 1, 15 and 31 respectively; it is in Libra. The stellar magnitude of Jupiter is −1·4; conditions for observation are not very favourable. Saturn is a morning star in Sagittarius, rising at the end of the month at 5h. 30m.; it is too close to the Sun for easy observation. Occultations of stars brighter than magnitude 6 are as follows, observations being made at Greenwich: Jan 1d. 05h. 08·8m., υ Leo. (*D*); Jan. 1d. 05h. 31·2m., υ Leo. (*R*); Jan. 22d. 22h. 09·8m., 26 Gem. (*D*); Jan. 26d. 03h. 04·9m., 6 Leo. (*R*). *D* and *R* refer to disappearance and reappearance, respectively. The Quadrantid meteors are active on January 3; the radiant is near R.A. 15h. 28m., Dec. +50°. The Earth is at perihelion on January 2, its distance from the Sun being 91·4 million miles.

Announcements

Sir Henry Dale has been elected an honorary member of the Biochemical Society. Sir Henry is one of the original members of the Society, and the appointment to honorary membership marks not only his distinction as a scientist but also his many years of service to the Society.

Mr. Edmund J. Cooper, who has had extensive experience of the development of voluntary associations, has been appointed general secretary of the Scientific Film Association.

Mr. W. A. Ferguson, of the Director's office of the British Museum (Natural History), has been appointed secretary of the Museum in succession to Mr. T. Wooddisse, who will retire on reaching the age limit on April 1.

The Institution of Mining and Metallurgy is to make grants in 1959 from the Bosworth Smith Trust Fund to assist postgraduate research in metalliferous mining (excluding mineral dressing but including surveying and geophysical prospecting). Projects may be supported for more than one year. Forms of application can be obtained from the Secretary, Institution of Mining and Metallurgy, 44 Portland Place, London, W.1, before February 28.

The Council of St. John's College, Cambridge, proposes not later than the end of April 1959 to make an election to the Kenneth Craik Research Award for the assistance of persons engaged in postgraduate research, preferably in physiological psychology. The value of the Award will be £450 a year. It will be tenable from October 1, 1959, for such period, not less than one year nor more than three years, as the Council shall decide. Applications should be sent to the Master, St. John's College, Cambridge, so as to reach him not later than March 14.

The Bradford Chemical Society, in conjunction with the Department of Chemical Technology of the Bradford Institute of Technology and the Yorkshire Council for Further Education, is holding a symposium on "Radiation Chemistry" on February 13 and 14 at the Bradford Institute of Technology, Great Horton Road, Bradford 1. Further information can be obtained from Dr. W. R. Moore at the above address.

The British Polarographic Research Society, 55 Oriental Road, Woking, Surrey, is organizing an intensive five-day course in polarography, to be held during January 12–16. Instruction in techniques will be given by specialists from the Technical Advisory Panel of the Institute. Further details can be obtained from the Secretary of the Institute.

THE NUFFIELD FOUNDATION

REPORT FOR 1957–58

IN its thirteenth annual report, covering the year ended March 31, 1958, the Nuffield Foundation records that, of the £8·5 million distributed during the fifteen years of its existence, about £6·5 million has been expended on ventures within the United Kingdom and £2 million in the overseas Commonwealth, of which grants totalling £850,000 were allocated in the year covered by the report. Of this total, about £1·75 million has been in the fields of science and technology, about £1·5 million in that of medicine, more than £1 million on the care of old people and research in aging, and about £1·25 million on social research and experiment and education. The present report places more emphasis than usual on the Foundation's interest in ventures designed to discover the facts relevant to human behaviour and relationships, and an outstanding illustration of this is the investigation into techniques of sampling and questioning which has been in progress since 1949 under Prof. M. G. Kendall at the London School of Economics. The Foundation has now made a grant of £35,000 over five years to enable the Unit to expand its work to include studies of the design of questionnaires, the validation of social inquiries, of interviewer–respondent bias and the motives behind the actual behaviour of people.

During the year the Foundation sought the views of leading biologists on the emphasis of its biological policy at a week-end conference at Tunbridge Wells, and the Foundation afterwards decided that biology should remain a major interest, not only because biological research is making its expected contributions to medicine and agriculture, but also because it is indicating the growing points in other disciplines, particularly chemistry. Accordingly, the Foundation will support work which promises to lead to a new understanding of biological processes, and the report refers particularly to the Foundation's interest in new developments in the analysis of synthetic systems, the control of enzymic synthesis, and the sequence of events that link particular nuclear components with the organization of the cell. In psychiatry it is interested in studies of behaviour and learning that throw light on the mechanisms involved, and it will continue to be interested in instrumentation, both for resolving existing biological processes and for the possible development of new techniques.

In accordance with this policy, a major grant of the year was £34,000 for the construction of an analogue computer at University College, London, resembling the nervous system of an animal, which will be trained to recognize shapes held in front of its model eye. The new computer, which is the outcome of Prof. J. Z. Young's work on the physiology of learning, should be able to simulate the learning of the alphabet and the numerals and a limited number of more complex shapes, which might include human faces. The Institute of Experimental Psychology, University of Oxford, has also received a grant of £10,000 over three years and nine months towards Dr. N. S. Sutherland's investigation of the mechanisms by which animals and human beings analyse stimuli and, in particular, how visual shapes are analysed. Two grants of £1,980 over three years and £900 over three years were made for investigations at the University of Reading on the structure of optic ganglia of the locust and their connexions and on the brain of the wood ant. A grant of £2,800 over two years was made towards Dr. K. E. Machin's work on physical aspects of behaviour, and a grant of £1,500 a year for two years to University College, London, was in support of three studies which are part of general research into the causes and treatment of mental deficiency: the search for rare or hitherto unknown cases of metabolic disturbance; dietetic experiments with selected amino-acids in cases of metabolic anomaly; and clinical trials of biologically active substances.

A grant of £15,000 over five years was made in support of Prof. B. Katz's work at University College, London, on nerve cells and muscle fibres, and further support of up to £1,500 a year for three years is being provided for Prof. J. Baddiley's work at King's College, Newcastle upon Tyne, on the chemical structure of bacterial cell walls. A programme of research into the effects of radioactive fall-out on wild animal population being undertaken by St. Bartholomew's Hospital Medical College is being supported by a grant of £3,200. A grant of £4,884 over three years was offered for a study of hybrid vigour at University College, London, and £800 a year for two years towards one of the acetate metabolism by *Chlorella*.

Towards Dr. J. D. Biggers's work at the Royal Veterinary College, London, on the growth of embryonic bones on chemically defined media, a grant of £3,200 over five years was offered, and one of £6,000 over three years was made to University College, London, in support of investigations on the mechanisms of processes catalysed by enzymes. For studies of pregnancy toxæmia and scrapie and myopathy in sheep at the Nuffield Institute for Medical Research, Oxford, a renewed grant of £7,500 for two years was made, and one of £6,500 over three years for research into the bacteriology of calf diarrhœa at the Royal Veterinary College, London. £12,000 was offered to the Marine Biological Association of the United Kingdom for the complete reconstruction of its aquarium. £2,200 a year for five years was given to the British Trust for Ornithology for a centre to collate, analyse and file the pooled data of bird observatories and to prepare reports. Up to £2,350 over three years was offered to the University of Glasgow for studies on the effects of physical and biological factors on spawning, while two interesting minor grants of £1,000 were made, one to Marlborough College towards the cost of apparatus needed for actual research into the magnetic susceptibilities of materials, and the other to the University of Leeds for the production of a series of films presenting the development of scientific ideas in a form suitable for sixth forms and undergraduates.

Besides administering the Oliver Bird Fund, the Foundation contributes an equal sum for fundamental and clinical research into the causes and cure of rheumatic diseases. Experience of the past four years points to the need for more centres specializing in rheumatism if more rapid progress is to be made.

Two problems in giving effect to such a policy are how to attract more clinicians into rheumatology and how to stimulate the interest of the pure scientist in the study of fundamental problems which may bear on rheumatism. Hope is expressed that work will soon begin on the difficult problems of what controls the behaviour of the fibroblast and what are the enzyme systems involved. Of four new grants in this field during the year, three have been given to centres already supported by the Foundation; the fourth, of £4,000 over two years, was to the Institute of Orthopædics for research on the constituents of cartilage. The controlled clinical trials of cortisone and allied hormones suggest that both prednisone and prednisolone are superior to cortisone in the treatment of rheumatoid arthritis and that there may be some fundamental difference between the action of these two steroids and cortisone. Of other grants for medical research may be mentioned one of £80,000 to endow a chair in child surgery at the University of London; up to £2,000 to the University of Leeds towards the cost of acquiring a Skeggs Leonard type of artificial kidney for comparison with the Merrill type; £2,250 a year for three years and a capital grant of £300 to the Institute of Neurology, University of London, for a long-term clinical investigation into the effects of hypotensive drugs and anti-coagulant therapy in the treatment of cerebro-vascular disease; a further grant of £10,700 over two years to the Tuberculous Meningitis Unit, United Oxford Hospitals, for research on disseminated sclerosis; up to £12,000 towards the cost of adaptations to the Pioneer Health Centre, Peckham, for a diagnostic centre for local doctors; and £2,520 a year for three years to the Institute of Psychiatry, University of London, for work on cutting the pituitary stalk.

Among the grants for the care of old people and research in aging are one of £2,500 to the National Institute for Adult Education for a comprehensive inquiry into existing educational facilities for the elderly, the use made of them, and the general role of adult education in helping people to adjust themselves to retirement and to continue leading an active life; £3,000 for a pilot study into the economic circumstances of people over retirement age; £2,000 over three years to the University of Exeter for an investigation into the effects of aging on the performance of tasks of varying complexity; and a further grant of a five-year fellowship rising from £1,500 to £1,700 a year to Dr. A. Comfort for his long-term investigations at University College, London, into the aging of fish and the pattern of aging in dogs and thoroughbred horses, which may yield information on the inheritance of longevity and the effects of parental age.

Other grants for social research and education during the year include: £6,850 over three years in support of a study of the social composition of a Lancashire industrial town, which will comprise an analysis of the number and functions of the professional, managerial and administrative groups and their role in the life of the community, and a study of the working-class population and its part in political and associational life and the relation of local to national culture. This study is being conducted by the Department of Social Anthropology and Sociology, University of Manchester.

A brief summary is given of the first part of Mr. J. Trenaman's study of the educational possibilities of radio and television, newspapers and films, towards which a further grant of £500 has been made. Broadcasting and the Press are the only contemporary influences that can reach across a majority of the population to the fringes of the 45 per cent that are resistant to education in its broader sense, and Mr. Trenaman thinks they could do more to stimulate critical thinking.

SCIENTIFIC BASIS OF LAND PLANNING IN THE TROPICS

An inescapable problem of the present-day world is the increasing pressure of population on land resources. Widespread knowledge and practice of death control have overtaken birth control so that, one by one, the countries of the world are experiencing the problem of how to match expanding population with expanding food production. The problem has now hit the Gambia, and in facing it the Gambian Government, perhaps influenced by the salutary lesson of the failure of the poultry scheme, is wisely realizing the fundamental need for a basis of factual knowledge on which to plan its land use and land planning policy. Rather more than a hundred and fifty years ago Britain, faced with the imminent possibility of a Napoleonic invasion, realized the need for adequate maps and set up the Ordnance Survey.

To-day, the far-flung parts of the Commonwealth face crises of many different types, and the Directorate of Overseas Surveys has been charged with the Herculean task of providing at least a skeleton map cover as a basis of operations. The maps the Directorate is producing are for the most part on a scale of 1 : 50,000 and are based essentially on air photographs. At the same time, the air photographic cover provides a wealth of other information, notably that of present land use. There are special reasons for using this information to prepare a series of land use maps* of the Gambia on the scale of 1 : 25,000. The sandy leached soils in the past have been worked on a system of bush fallowing but produce only indifferent crops of sorghum, millet with some cassava and maize and groundnuts as a cash crop, and a little upland rice. With increased population the period of fallow is so shortened that the soils do not recover and the system breaks down. With Government aid, attention has been turned to the clearance of mangrove and grass swamps bordering the Gambia River and the cultivation of their heavy clay soils for rice. This is more revolutionary than it sounds, because, traditionally, the women have cultivated the land; but swamp clearance, construction of bunds and causeways and mechanized

* Directorate of Overseas Surveys. Gambia Land Use Map, Sheet 12/1: Janneh Kunda. Gambia Land Use Map, Sheet 14/11: Mansa Konko. (Scale 1 : 25,000.) (Tolworth: Directorate of Overseas Surveys, 1958. Obtainable from Edward Stanford, Ltd., 12 Long Acre, London, W.C.2, and the Survey Department, Bathurst, Gambia.) 3s. 6d. each.

ploughing are man's work. The policy has apparently been successful: the reclaimed areas can be pointed out with pride; the old 'hungry season' of March–April seems to have disappeared. Yet rice imports are increasing. Can it be that as new areas are reclaimed, equally large areas of upland are being abandoned? Unfortunately, there are no map records, and we see here the inadequacy of statistics where a complete shift in cultivation from one part of an administrative unit to another would not appear at all in any statistics of land use. There could, indeed, be no clearer demonstration of the complementary character of cartographic and statistical–economic interpretation of data, or the inadequacy of the latter without the former.

The work in the Gambia has been carried out under the direction of Mr. Martin Brunt, land use officer of the Directorate of Overseas Surveys, working on air photographs coupled with three periods on the ground for vital checking. He used series of photographs taken in 1946 by the Royal Air Force and another series taken in 1956 by Aircraft Operating Co. (Aerial Surveys), Ltd. The fully coloured maps are able to show, therefore, the extension or retraction of rice lands.

It is characteristic of tropical agriculture that the intricate pattern of land use is apt to defeat the cartographer even on large scales. Gambia is no exception. In the two published sheets out of the projected thirty-five sheets for the central Gambia, six colours are devoted to cropland, three being for rice according to the proportion of the land cultivated—the actual plots are too small. The tidal flats show a complex mixture of high and low mangrove and grass marshes with a little 'barren marsh'. On high ground a distinction is made simply between 'woodland', 'fallow bush' and grass.

In due course an explanatory memoir is promised —no conclusions are drawn at this stage. In the meantime, there can be nothing but praise and admiration for all concerned: a far-sighted Government for commissioning a survey and the publication of a factual document in the form of maps which cannot fail to be of permanent value for all time; a technically excellent publication; and a land use officer who understands clearly the problems involved.

A somewhat similar problem in a still more acute form is presented by the island of Singapore. More than a million and a half people are crowded into an area the size of the Isle of Man. The urgent questions are largely those of town planning, but there are patches of land excellent for intensive market gardening, producing much-needed fresh vegetables for the local market; there are light lands with excellent coconut groves; and, though pineapples have been ousted and rubber is being squeezed out, poor soils remain in second growth scrub protecting water supplies. There are swamp lands inviting reclamation, and once again a careful record and understanding are vital. In this case the mapping is being carried out by the University of Malaya. The survey tradition established in the Department of Geography by Prof. E. H. G. Dobby (now of Ghana) is being ably continued by Robert Ho, Paul Wheatley and their team, and the first sheet* out of ninety-four projected on the scale 1 : 6,336 (10 in. to the mile) has just been published for the Singapore Improvement Trust. Some twenty categories of rural land use are shown, and in addition urban land uses are fully delineated. Like the map of the Gambia, this constitutes a factual document of utmost and lasting value. By showing things as they are and then in the explanatory memoir which is in preparation attempting an explanation, we are led away from that dangerous short cut of mapping 'land capability classes' decided so frequently on inadequate knowledge and based inevitably on a subjective judgment with present-day conditions in mind. L. Dudley Stamp

* Singapore Land Use Map, Sheet S/49. Singapore Improvement Trust. 1 : 6,336. Field work by Geography Dept., University of Malaya, July 1958.

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

REPORT FOR 1957

THE third annual report of the European Organization for Nuclear Research* (CERN) covers the period to the end of 1957 and includes a list of the twelve member States of the Organization; their percentage contributions to the budgets for the years 1957, 1958 and 1959; details of the structure and membership of the council; and a list of the names of the senior staff of the Organization.

During the period under review, the constructional work on both the proton synchrotron and the synchro-cyclotron accelerators and the buildings on the Meyrin site has progressed according to schedule. The 600-MeV. synchro-cyclotron came into operation on August 1, 1957, and already an interesting programme of research under the supervision of Prof. M. Bernardini, the research director of the Synchro-cyclotron Division, has commenced. Details of the construction and testing of the accelerator are given in a separate section of the report. They include the investigation of properties of the internal proton beam; the installation of the several beam-bending magnets; the construction of the final shielding wall to give protection against neutrons; and the fitting of appropriate channels for mesons and neutrons. The Proton-synchrotron Division has passed the design, planning and ordering stage, and has entered upon the active phase of the construction of the machine and of its ancillary equipment. The whole Division, consisting of 165 staff members engaged on the design and construction of the synchrotron and nine Fellows in the research group studying new ways of accelerating particles, is now installed at Meyrin, and the old offices and laboratories at the Institute of Physics in Geneva have been vacated. The first scheme to be studied by the research group was the plasma ring accelerator proposed by Budker at the CERN Symposium in 1956. Both theoretical studies and experimental studies with an air-cored betatron have been carried out. It is expected that the experiments will indicate the general utility of plasma ring discharges as accelerator guide fields.

The offices, laboratories, experimental halls and the ring complex are all finished and occupied by

* European Organization for Nuclear Research. Annual Report, 1957. Pp. 86 (25 plates). (Geneva: CERN, 1958.)

the Proton-synchrotron Division, and apart from minor installations and some road work, there remains only the power house, containing the magnet generators, water-cooling apparatus and electrical sub-station for the whole machine, to be completed. Consideration has already been given to the research programme for the 25-GeV. machine, which is planned to become operational in 1960. At an energy of 25 GeV. the usual methods of particle analysis and detection break down, and therefore a preliminary period devoted to the study and development of the necessary large and expensive experimental equipment required is desirable. A short list of nine typical experiments which has been drawn up is given in the report.

Unlike the accelerator divisions of the Organization, the Theoretical Study Division is not bound to follow a construction time-schedule, and its scientific output has already been considerable. It will, however, be greatly stimulated when the experimental groups become fully operative, for then it will enjoy the benefit of obtaining its data at source. The Division is mainly concerned with the investigation of the so-called elementary particles, their number, structure, properties and interactions. The lists of publications originating from the Division, and the colloquia held at the Institut de Physique in Geneva until June 19, 1957, and at the Meyrin site until the end of the year, together with the lectures and colloquia of the Division at Copenhagen, are given in appendixes to the report. The number of members of the Division greatly increased during the year and included senior physicists from non-member countries who were able to pursue their studies in the Organization's laboratories through grants provided by the Ford Foundation.

In the Scientific and Technical Services Division, the main spheres of development of experimental techniques were liquid-hydrogen bubble chambers and electronic evaluation of track photographs. In addition, a health physics section was started, and the Division continued to administer the Scientific Information Service and the Cosmic Ray Research Group.

The hydrogen-liquefying plant mentioned in last year's report was installed in the summer of 1957 and liquid hydrogen was produced for the first time in July 1957. The plant produces about 32 litres per hour. The 10-cm. bubble chamber was completed during the year, and an illustration of it, together with photographs of other equipment, is included in the annual report.

THE AUTOMATIC COMPUTING ENGINE AT THE NATIONAL PHYSICAL LABORATORY

THE Automatic Computing Engine, or ACE, is the latest digital computing machine to be built at the National Physical Laboratory for the use of its Mathematics Division. This new machine, with its increased speed of operation, its larger storage capacity and its many additional functional facilities, is a considerable advance as a computing tool on its predecessors, the experimental pilot-model, ACE, and its engineered counterpart, DEUCE.

It is not easy to assess the speed of a machine from the times taken to carry out the elementary arithmetical and logical operations. This is particularly true of any machine with a high-speed store of less than about 8,000 words, on which many problems will demand the use of the backing-up store. The times taken for a few basic computations probably give as accurate a picture of the overall speed as can be obtained without a detailed study.

(1) The zeros of a polynomial of the 16th degree may be obtained in an average time of 15 sec. Because of the long word-length (48 digits), accurate roots even of very ill-conditioned polynomials of this degree will be obtained. Polynomials of degrees up to about 250 may be found without using the drum-store, though no particular loss in speed results from using the drum on such problems.

(2) A set of simultaneous equations of order 30 can be solved in about 5 sec. Even if none of the coefficients is zero, sets of orders up to 170 may be solved, the time taken varying approximately as the cube of the order but being slightly less for higher orders.

(3) The solution of Poisson's equation, $\nabla^2 V = 4\pi\rho$ on a square with 400 mesh points, may be obtained in about 75 sec. This time is for the direct solution of the finite difference equations and will give values correct to at least ten decimals. After solving one such problem, solutions corresponding to different distributions of ρ may be obtained in about 15–20 sec. each.

ACE is a serial computer in which numbers and instructions have 48 binary digits; the digit-rate is 1·5 million per second, and therefore its word-time or minor cycle is 32 microseconds.

The main working store consists of twenty-four mercury delay lines each containing thirty-two words, circulating in a major cycle of 1,024 microseconds. Rapid-access storage is obtained by using mercury delay lines with capacities of one, two and four words. The backing store consists of four magnetic drums containing a total of 32,768 words.

The ACE instruction specifies a three-address operation of the form '*A* function *B* to *D*', where *A* and *B* are the store-addresses of the operands and *D* is the store-address to which the result of the operation is to be sent. Instructions also specify a further store-address, *N*, from which the next instruction is to be extracted. The time needed to execute this operation (for single-length numbers) is 32 microseconds, and since each operation may be followed immediately by another, a maximum rate of operation of 30,000 per second is possible.

The drum-store, the multiplier and the divider are independent units. These are put into operation by the appropriate instructions and then work independently until they have completed their operation. This feature provides a parallelism of operation, since a multiplication, division, drum-transfer and a series of ordinary operations could be in progress at the same time.

The three-address operation of the machine allows the multipliers and multiplicand to be selected and the multiplication process to be initiated by a single

instruction. The product is formed in fourteen minor cycles, that is to say, in 430 microseconds. The division process is similarly specified, and the quotient (rounded or unrounded) is formed in approximately 1·5 milliseconds. The divider also contains an automatic standardizing process for use in floating-point arithmetical operations.

The magnetic drum-store has a total capacity of 1,024 long delay lines, that is to say, about 1·5 million digits. There are four drums each having 256 tracks, each track storing the contents of one delay line. Each drum has sixteen read heads and sixteen write heads, the 256 tracks being obtained by moving the heads as one unit into one of the sixteen discrete positions. Each drum is 6·75 in. long by 5 in. in diameter, allowing a linear digit packing of 100 per in. The drum is driven by a hysteresis motor running synchronously at 12,000 r.p.m. and is phase-corrected so as to rotate exactly once in five major cycles of the machine.

Punched card and magnetic tape equipment will be provided for input and output. The installation will initially consist of two machines: (1) a broadside card reader, running at 450 cards per min.; (2) a broadside card punch running at 100 cards per min. In order to read or punch 80 columns of a card the computer has an 80-digit input dynamicizer and an 80-digit output staticizer.

The ACE has been designed and constructed to allow easy maintenance. Extensive marginal checking facilities are provided and the chassis units are designed to give complete accessibility to all components, valve connexions, etc.

The machine is housed in ten cabinets, each having a cooled air-circulation system. Each cabinet is fitted with a rising door which permits immediate access to all the twenty-four chassis units contained therein. The number of valve envelopes is about 6,000.

J. H. Wilkinson
D. W. Davies

THE ADÉLIE PENGUIN

DETAILED observations of the Adélie penguin, *Pygoscelis adeliae*, have been carried out by Dr. W. J. L. Sladen of the Falkland Islands Dependencies Scientific Bureau and the Edward Grey Institute, University of Oxford*.

The Adélie is antarctic and circumpolar in its distribution, but does not breed north of the South Sandwich Islands and Bouvet Island. It is the most abundant and widely distributed of all the antarctic penguins.

Two rookeries were studied between 1948 and 1951, one at Hope Bay, Graham Land, and the other at Signy Island, South Orkneys. At both of these there survived a small number of birds that had been ringed two seasons before. The only certain way of determining the sex of these penguins, other than by dissection, is to mark breeding birds before egg-laying and to continue observing them during the early part of the breeding season. Casuals and non-breeders cannot be sexed unless marked and recovered breeding in another season.

The diversity in behaviour of a penguin community appears to be due to three factors which are often inter-related: variation among individuals, differences in 'intensity' of behaviour, and differences in age and breeding experience. Emphasis is laid on the differences in age and breeding experience, and some evidence is given from field observations and dissections to show that this is an important factor.

Suggested age-groups divide a population seen at the rookery into five categories: the experienced (established) breeders, the inexperienced (unestablished) breeders, the non-breeders ('wanderers') in adult plumage, the non-breeders in immature plumage (yearlings), and the nestlings.

The established breeders, probably four or five years old and more, come back to their former nest-sites independently of their former mates. Such a bird may 'keep company' with another bird of the opposite sex until its true mate returns.

The unestablished breeders have first to establish themselves and pair off. Their behaviour differs somewhat from that of the established birds, though with some overlap due to individual variations. They often arrive back later than the established breeders, and take up territories on the periphery of the colonies, or fill vacant places within them. They are the cause of most of the fighting. Courtship behaviour is more prolonged, egg and chick mortality higher and breeding efficiency lower.

The non-breeding 'wanderers' in adult plumage are two or three years old and can be seen wandering around the rookery in small parties, and even visiting rocky outcrops up to 1,000 ft. above sea-level far away from the breeding area. Some of them build poor nests, or occupy vacant sites for a short time before moving elsewhere or being turned out by older birds. Of the wanderers which were dissected, some showed undeveloped gonads despite their adult plumage. It is this age-group which, together with some of the unestablished birds, under favourable conditions, occupy new ground and thus extend the range of the species. They will also quickly take the opportunity to fill any gap in the colonies, and may during the re-occupation period occupy territory in anticipation of the following season.

The yearlings, which are easily recognized by their white throats, normally live among the pack ice, but are occasionally seen at the rookery, where they associate with the wanderers. Several were seen building nests in a half-hearted way on the edge of colonies; but, like the wanderers, they never stayed in one place for long.

Describing the displays and postures of the Adélie penguin, Sladen shows that during the first and second fasting periods the ecstatic display is confined to the male, its most important function appearing to be in pair-formation. A lone male by this display can attract a nearby female to its nest. After the eggs have hatched (or should have hatched), it is also seen in females, though on a diminished scale. It is more commonly seen among the younger and unestablished breeders or non-breeders than among the established breeders.

* Falkland Islands Dependencies Survey. Scientific Reports, No. 17: The Pygoscelid Penguins. 1: Methods of Study. 2: The Adélie Penguin *Pygoscelis adeliae* (Hombron and Jacquinot). By Dr. William J. L. Sladen. Pp. 1+97+12 plates. (London: H.M. Stationery Office, 1958. Published for the Colonial Office.) 47*s*. 6*d*. net.

The 'bill to axilla' display, here described for the first time, appears to be closely related to the ecstatic and is probably also associated with pair-formation. Its resemblance to one of the attitudes of threat suggests that this display has in it a greater element of repulsion for the same sex and less attraction for the opposite sex than has the ecstatic. A possible relation to nervous strain of the ecstatic and 'bill to axilla' displays in some situations is suggested.

Bowing is believed to be both a posture and a display, and it is suggested that the display is associated with early pair-formation, and is possibly a form of appeasement ceremony.

Both sexes share the duties of nest-building. The Adélie's habit of stealing stones suggests that it serves a useful purpose in distributing stones throughout a colony from the outside towards the centre, thus reducing the necessity for long treks.

The breeding season starts when birds return to the rookeries in September and October and occupy nest-sites. They may have to travel 200 miles or more from their winter quarters, the last stage being over many miles (up to sixty) of rough sea ice. The occupation period is the period from arrival until the last egg has been laid. Evidence is given from marked birds that, once established, Adélies are, on the whole, very faithful to their old nest-sites from year to year, and keep the same mates. Nest-sites are often covered by a foot or more of snow, yet Adélies appear to come back to the same spot.

The normal clutch is two eggs, the interval between the first and second being 2–4 days. If eggs are removed as soon as laid, a third one is sometimes produced. Adélies are single-brooded. The average incubation period (from the day of laying until the chick is completely out) is thirty-five days with a range of thirty-three to thirty-eight days.

The care of the young is divided into three stages: the guard stage when one of the parents is at the nest to care for and feed the chicks while the other is away collecting food; the crèche stage, when the chick is left alone at an age of about 4 weeks and groups with others to form crèches of 100 or more chicks, and, later, the dispersal of the crèches. Evidence is given from a study of marked adults and chicks that parents feed their own chicks in the crèche, feeding others only in exceptional circumstances. There are no adult 'guardians' of the crèches. These two facts are contrary to previous accounts of penguins the chicks of which group together in crèches.

The Adélie's habit of 'keeping company' (that is, the partnership of two birds of opposite sex at a nest-site which may, or may not, lead to the establishment of a mated pair) is believed to have survival value in facilitating the formation of new pair-bonds should the original mate of an experienced breeder fail to return, or return very late.

Most Adélies moult away from the rookeries among the pack ice. The yearlings moult first. Little is known about the winter movements of the Adélie, but the birds appear to stay in the pack ice and visit land in winter only when gales break up the fast ice and bring the pack close to land.

REINFORCED PLASTICS

A CONFERENCE on reinforced plastics, organized by the British Plastics Federation, was held in Brighton during October 22–24. Twenty-four papers were presented, and a morning was devoted to short talks by representatives of industries which use plastic components.

For structural purposes, high polymers in bulk form are inadequate in strength and stiffness. After surface imperfections have been removed by acid polishing, bulk glass has great strength, of the order of 250,000 lb./in.^{2}, but it is structurally unsuitable, because of the ease with which the surface is damaged and because of the low average stress at which cracks are propagated from regions of damaged surface. By subdividing the glass into fine fibres, and bonding these together with a polymer, a useful two-phase structural material is obtained which is readily shaped during manufacture and which has high resistance to the propagation of cracks. The glass fibres are used in the form of rovings, chopped strand mat or woven fabrics. The polymers are usually polyesters or epoxides which have suitable mechanical properties at temperatures up to 150° C. Silicones are used where parts are required to operate at temperatures above 150° C., and they retain useful strength properties up to 250° C.

Typical strength data for polyester glass sheet materials at room temperature are given in Table 1.

Table 1

Reinforcement	Bidirectional glass fabric	Unidirectional glass fabric	Glass mat
Percentage glass by weight	60–65	62–67	30–45
Tensile strength (lb./in.^{2} × 10^{-3})	40–50	78–86	10–24
Young's modulus (lb./in.^{2} × 10^{-6})	1·0–2·8	4·0–5·0	1·0–2·0

Polyester and epoxide resins are first prepared as linear polymers, containing double bonds; at this stage they are viscous liquids. During preparation, water of condensation is removed. The linear polymers are then cross-linked using a monomer such as styrene or dicyandiamide. Cross-linking is achieved with the aid of a catalyst and may occur at room temperature or at an elevated temperature. Little condensation product is produced and little pressure is necessary.

There is at present little knowledge of the nature of the interface between glass and polymers. Glass is normally covered with a film of moisture in which soluble constituents of the glass dissolve. This film may prevent adhesion to the polymer or inhibit polymerization locally. Various finishes, of which vinyltrichlorsilane is an example, are available for application to glass; by reacting with the moisture film, these are thought to become chemically bonded to the silica in the glass, and to present an unsaturated hydrocarbon surface for adhesion to the polymer. The treatment of glass fibres with such finishes yields a more durable plastic under wet conditions, but there is not yet sufficient experience to enable a reliable assessment to be made of long-

term durability. At the conference it was reported that a set of unstressed polyester-glass test pieces showed no deterioration in strength after exposure to English weather for two and a half years, and static-water tanks of the same material have now been in use for the same period with little apparent deterioration.

When loaded to higher stresses, test pieces subjected to cycles of wetting and drying and to increase and decrease in temperature show deterioration in properties. Epoxides are generally superior to polyester under such conditions. Further research is necessary to produce a better understanding of the nature of the deterioration.

The behaviour of plastics reinforced with glass under cyclic loading is interesting. Glass alone withstands a cyclic loading for about the same time as it withstands a steady load equal to the maximum occurring during the cyclic loading. This delayed fracture under steady load is known to be caused by attack of the atmosphere. With plastics reinforced with glass, once the adhesion between glass and polymer has failed, atmospheric attack can take place, especially if the polymer has crazed; but deterioration under cyclic loading may also be associated with damage to the glass surface when it slides in the polymer matrix or rubs against another fibre and with local non-uniformity of the distribution of load among the fibres.

Plastics reinforced with glass fail under cyclic loading in a shorter time than would produce failure under static loading of the same intensity. They therefore display a definite fatigue effect as well as delayed fracture. The relatively high resistance to propagation of cracks is shown by cyclic loading tests on notched test-pieces. For a given notch and nominal stress cycle, the number of cycles to failure may be higher for the plastic than for aluminium alloy.

In plastics reinforced with fibre, each fibre contributes to strength and stiffness only in the direction of its length, and it has been calculated that a two-dimensional isotropic mat of fibres should have strength and stiffness equal to one-third of that of the longitudinal strength of an array of parallel fibres. In principle, glass flakes, if of equal breaking stress, should form a sheet material three times as strong and stiff as a material reinforced with fibre. Preliminary experiments with glass flake material reported at the conference showed considerable increase in stiffness, but the expected increase in strength was not achieved, probably because of damage at the edges of the flakes.

Originally developed for aircraft radomes, plastics reinforced with glass are finding increasing application in a wide variety of components. These include boats (including ship's lifeboats), car bodies, bus and railway wagon-tops, translucent building panels, ventilation ducting, tanks for the chemical industry, partitions for aircraft and ships, and jigs and press tools. Their development has been a co-operative effort of physicists, chemists and engineers. Their further development will depend on the invention of stiffer glass, of resins more stable chemically and on research into the mechanism of deterioration and fracture.

C. GURNEY

WHEAT GENETICS

DURING the ninth International Congress of Genetics, held at Bellagio in 1953, a small group of participants resolved to organize in the future special meetings at which the objects, results and techniques of current research in wheat cytogenetics could be discussed, and at which workers in the field could be brought into personal contact. As a result, the first International Wheat Genetics Symposium was held during August 10–15 at the University of Manitoba, Winnipeg, Canada. Some 150 participants from twenty-nine countries assembled to join in the formal sessions and in informal discussions, and to see something of the famous wheat-growing region of Manitoba.

The formal meetings were held under the general chairmanship of Dr. H. Kihara (Japan), who, in his opening remarks, recollected that it was exactly forty years since the correct chromosome numbers of the polyploid series in wheat were determined by Sakamura and by Sax. The intervening years had seen intensive research in the sub-tribe Triticinae, and this work had contributed to making the cytogenetic composition of common wheat, *Triticum vulgare*, better understood than that of any other polyploid species. Among the themes of the symposium were some of those which have been most prominent over the years in wheat cytogenetics, notably the investigation of the inheritance and the utilization of disease resistance, the study of the genetic make-up of wheat using aneuploids and the study of interspecific crosses.

In distilling the essence of many years of research into the application of backcrossing to plant breeding, and particularly to breeding for disease resistance, Dr. F. N. Briggs (United States) emphasized that these methods could only be applied when suitable recurrent parents were available and where improvement was required over only a limited sector of the total range of genetic variation. Combination of backcrossing with any other method, although sometimes necessary, meant departing from the security of a tested genotype.

Backcrossing is being used by Dr. N. E. Borlaug (Mexico) to produce multi-line varieties of wheat designed to combat stem rust, the biggest single disease hazard to world wheat production. Numbers of different rust resistant parents are backcrossed into a common, generally useful, but rust susceptible, recurrent-parent variety. When the recurrent variety has been reconstituted in each backcross line to such an extent that there is little difference between them, except the source of their disease resistance, seed of the lines can be mixed in various proportions to form multi-line varieties. Since the multi-line variety includes several genetically distinct types of disease resistance, it is likely that during a rust attack some of its component lines will be resistant to the prevalent races of the pathogen. The risk of catastrophic crop failures will therefore be minimized, both on account of the yield returned by the resistant lines and because the lower proportion of susceptibles will limit the build-up of the epidemic. The actual

composition of a variety may be changed from time to time to counteract altered frequencies of rust races, and as many as eight lines may need to be included in one variety. The first trials suggest that even in the absence of disease there may be some advantage in growing the multi-line varieties primarily designed to restrict rust.

The importance of developing the disease resistance, and especially the rust resistance, of the wheat crop was underlined by two further contributions. Dr. D. R. Knott (Canada) has analysed twenty-nine varieties of wheat in which he has discovered seven different genes governing stem rust resistance. Some varieties had no genes for resistance, others had up to four, and moreover the genes differ in the level of resistance conferred and in their dominance relationships. By monosomic analysis, the chromosome on which each gene is carried has been determined, and now each gene is being separately studied, in the absence of all other genes for resistance, in a common genetic background. Dr. Knott's work, in conjunction with information on the spectrum of race reactions due to each gene, permits a more rational approach to the utilization of sources of rust resistance in breeding programmes than has previously been possible.

Indeed, this work comes part way to meeting the wishes of Dr. A. R. de Silva (Brazil), who pleaded for a more precise identification of genetic variation in the host and pathogen as a preliminary to the scientific incorporation of rust resistance in breeding material. He considered that host–pathogen relationships should be envisaged in terms of genes for resistance versus genes of pathogenicity, rather than in terms of rust races versus varieties differing in race response.

In discussing these papers, Dr. E. C. Stakman (United States) proposed that resistance was perhaps not simply attributable to single genes, since it depended on the overall physiology and morphology of the plant. Disease resistance was also among the criteria on which Dr. R. de Vilmorin (France) and Mr. H. C. Thorpe (Kenya) placed considerable value in breeding new wheat varieties for their own areas, but both emphasized that overall suitability of varieties was essential, and that this could not be neglected for the sake of particular characteristics.

T. vulgare is extremely tolerant of many aneuploid conditions in a way which forces recognition of the close genetic relationship between the three genomes of which it is composed. Dr. E. R. Sears (United States) has been prominent among those who have exploited the tolerance of aneuploidy in the cytogenetic analysis of wheat. His work commenced with the development of the twenty-one lines monosomic in turn for each of the chromosomes of wheat. By using the monosomic series in crosses with euploids in other varieties it has been possible to analyse some of the genetic differences between varieties. Additional genetic knowledge was obtained from studies of the nullisomic derivatives of monosomics. The seven homœologous groups of three chromosomes representing the equivalent chromosomes of each of the three genomes of wheat have been established by nullisomic–tetrasomic compensation, and the chromosomes in each genome have been determined by crosses of monosomics to stocks deficient for one or other complete genome. Dr. Sears's monosomic series has provided the basis for extensive aneuploid work in Canada which Dr. J. Unrau (Canada) reviewed. Monosomic series have been developed in more than eight wheat varieties, and some genetic analysis of disease and insect resistance and of certain morphological characters has been accomplished. The genetic breakdown of polygenically inherited characters by aneuploid techniques has now commenced. In the Canadian work the reciprocal exchange of intact chromosomes between varieties is a new source of genetic information, a striking example of which is that the substitution of a particular chromosome pair from another variety may increase the yield of the recipient variety by 50 per cent.

The extent of the genetical duplication, or triplication, in hexaploid wheat was stressed from results with induced mutations in diploids, tetraploids and hexaploids by Dr. J. Mac Key (Sweden) and by Dr. S. Matsumura (Japan). This underlined the pronounced triplication of genetic material which is indicated by the recognition of the homœologous groups by nullisomic–tetrasomic compensations. A puzzling problem has been to reconcile genetic triplication of this order with the purely diploid form of meiosis found in *T. vulgare*. However, Dr. R. Riley and Dr. G. D. H. Bell (England) were able to present evidence, confirmed by Dr. Sears, that the cytologically diploid behaviour of hexaploid wheat is controlled by genes on one chromosome, in the absence of which there is pairing between equivalent, homœologous, chromosomes of the different genomes. Thus, genetical triplication in hexaploid wheat can be associated with high fertility and genetical stability because of a genotype which imposes a bivalent-forming regime.

Aegilops squarrosa, the species which contributed the *D* genome of *T. vulgare*, would not be chosen by most plant breeders as a parent in a breeding programme. Yet its chromosomes are undoubtedly present in common wheat; a circumstance which Dr. L. Shebeski (Canada) considers may limit the advances to be made by breeding within the species. Consequently, he and Dr. B. C. Jenkins are producing entirely new sets of seven chromosomes, less restricting in gene content, to replace the *D* genome. The very vigorous amphiploids between tetraploid wheat and rye were made with similar objects by Dr. E. Sanchez-Monge (Spain), and their derivatives may have practical value in certain marginal environments where rye is at present the only suitable cereal crop.

The difficulties of handling the concepts of genome analysis were described by Dr. H. Gaul (Germany), and other considerations in the study of polyploids were discussed by Dr. R. Riley and Dr. G. D. H. Bell (England), who compared the behaviour of a range of synthetic amphiploids with that of related natural polyploids. This work includes studies on the cytogenetics and breeding value of lines in which single pairs of rye chromosomes are added to the full complement of wheat chromosomes, or in which a single pair of wheat chromosomes is replaced by a single rye pair.

The conservation of natural variation in an economically prominent group like *Triticum* is clearly an important consideration, and the maintenance of collections of varieties potentially useful in breeding programmes was described by Dr. J. B. Harrington (Food and Agriculture Organization, Rome) and by Dr. L. P. Reitz and Dr. D. J. Ward

(United States). However, as Dr. A. T. Pugsley (Australia) pointed out, no system was in existence to co-ordinate the maintenance of wheat material of experimentally determined genetic constitution, and one of the practical accomplishments of the symposium was the formulation of a scheme to do this.

A useful session dealt with the application of the induced mutations to plant breeding, during which Dr. R. S. Caldecott (United States) considered the control of the mutation process.

The symposium illustrated the general realization that if the maximum benefit is to be obtained from common wheat which, with rice, is one of the world's most important food crop plants, the fullest understanding of its genetic architecture will be necessary. Already, however, the cytogenetic structure of wheat is better known than that of any other polyploid species, so that work on wheat is profoundly influencing general ideas on evolution by polyploidy and on the genetic functioning of polyploid organisms. The present position has resulted from combining the efforts of many workers over the years. Future progress will similarly be achieved by the accumulation of numerous individual contributions, and so will be most rapid and efficient if the people engaged are enabled to pool their ideas in the way which was possible at the first Wheat Genetics Symposium.

RALPH RILEY

INDIUM MONO-TELLURIDE

By H. C. WRIGHT and J. C. BRICE

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SOME preliminary work has been carried out on the mono-telluride of indium. This revealed some anomalous properties of the compound, which is variously reported as semiconducting[1] and metallic[2]. The compound was prepared by direct fusion of stoichiometric amounts of the elements in sealed evacuated silica tubes. X-ray powder patterns of the compound showed only the lines reported by Schubert[3].

The resistivity and Hall coefficient were measured on four specimens at room temperature. They all showed a carrier density of 10^{18} holes cm.$^{-3}$ or more, and resistivities varying from 4×10^{-3} to 4×10^{-2} ohm cm. In an attempt to change the carrier type, specimens were prepared with 4 atomic per cent excess of each of the elements, respectively. The sign of the thermoelectric power of both these suggested p-type conduction.

The temperature coefficient of resistance was metallic from liquid nitrogen temperature to 440° K., at which point an anomaly was observed (Fig. 1). These measurements were made with increasing temperature. On cooling, the resistance at any given temperature was found to be dependent on time. This was investigated by holding a specimen at 463° K. for 16 hr. and cooling over a period of 15 min. to 358° K. The rate at which resistance at time t (R_t) approached its equilibrium value (R_∞) is shown in Fig. 2. It was found that measurements could be repeated provided adequate time for relaxation was allowed.

The thermal electromotive force was measured against copper, using an apparatus described elsewhere[4]. It varied from $1{\cdot}5 \times 10^2$ μV. °K.$^{-1}$ at 300° K. to $2{\cdot}2 \times 10^2$ μV. °K.$^{-1}$ at 580° K. without anomaly. A point-contact diode of the material showed no rectification for currents up to ± 100 m.amp.

Differential thermal analysis was carried out with a standard Gallenkamp apparatus using equal parts of tellurium and silica as a reference material. The results of two runs taken between 370° K. and 530° K. are shown in Fig. 3.

The thermal conductivity of the material was measured by holding one side of a thin disk at the ice point and the remote side in contact with a heated surface at temperatures varying from 290° K. to 490° K. The rate of heat transmission through the disk was deduced from measurements of the power necessary to maintain the heated surface at a given temperature θ with and without the disk in position. Each temperature was maintained for 15 min. These results are presented in Fig. 4 in the form of a graph of WL/A against θ, where W is the rate of heat transmission through the disk of thickness L and cross-sectional area A: the slope of this graph at any temperature yields the thermal con-

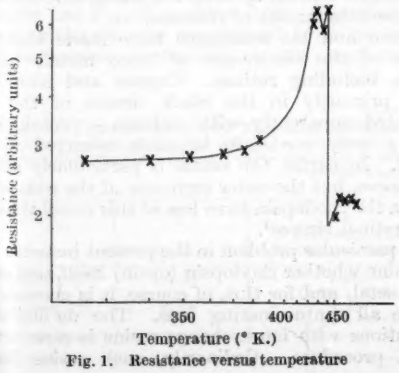

Fig. 1. Resistance versus temperature

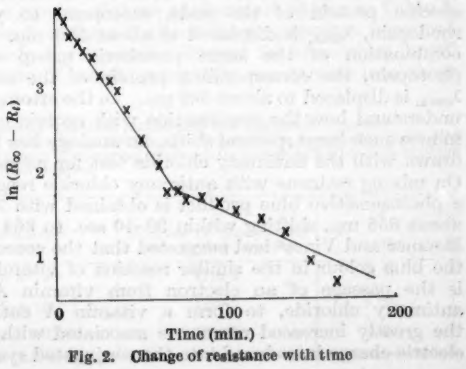

Fig. 2. Change of resistance with time

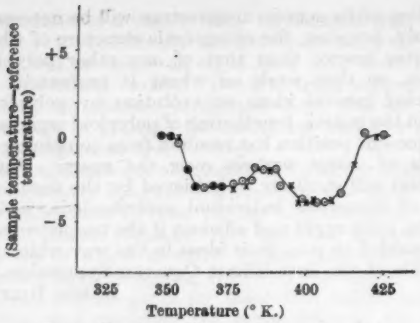

Fig. 3. Results of differential thermal analysis

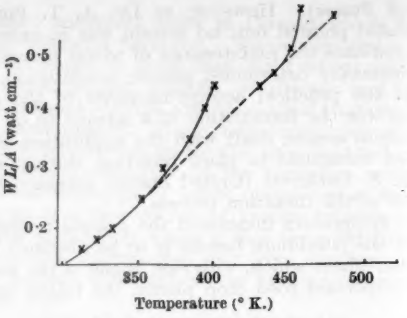

Fig. 4. Thermal conductivity

ductivity of the material at that temperature. This is about 2×10^{-3} joule cm.$^{-1}$ °K.$^{-1}$ except in the two regions between 363–393° K. and 448–473° K., where it is anomalously high.

An optical energy gap was sought by direct reflexion measurements but not found in the range 0·85–2·5μ. Powder reflexion measurements between 0·2 and 1μ yielded no evidence of an energy gap either. A practically constant photo-voltaic effect was seen to be present between 0·85 and 2·5μ. This could be attributed to the junction between the specimen and either of the *Leitsilber* (by Degussa, Frankfort) painted electrodes on it.

The double relaxation time apparent in Fig. 2, the differential thermal analysis result in Fig. 3 and the thermal conductivity graph, Fig. 4, all suggest that two-phase change mechanisms operate between room temperature and 450° K. The resistance/temperature graph shown in Fig. 1 indicates only one change, at 440° K.

Electrical measurements slightly favour a metallic model for the compound in view of the sign of the temperature coefficient of resistance, and the non-rectification of the point contact diode. The large value of the thermal electromotive force, the computed Wiedemann–Franz ratio of 2×10^{-7} V.^{2} ° K.$^{-1}$ at 300° K. and the large variation of resistivity are, however, more characteristic of a semiconductor than a metal.

Much of the preparative work was carried out by Mr. E. M. N. Baldwin and many of the measurements were made by Miss J. Schwarz.

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DOES RHODOPSIN CONTAIN A TRACE METAL?

By ISAO FUKAMI, Prof. BERT L. VALLEE and Prof. GEORGE WALD

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ONE of the problems involved in the study of the visual pigments is the source of their colour. In rhodopsin, for example, the prosthetic group neo-*b* (11-*cis*) retinene has $\lambda_{max.}$ in aqueous digitonin solution at about 384 mμ. On combination with the specific protein of the rods, scotopsin, to yield rhodopsin, $\lambda_{max.}$ is displaced to about 500 mμ. On combination of the same prosthetic group with photopsin, the corresponding protein of the cones, $\lambda_{max.}$ is displaced to about 562 mμ. In the attempt to understand how the combination with protein could induce such large spectral shifts, an analogy has been drawn with the antimony chloride test for retinene[1]. On mixing retinene with antimony chloride reagent, a photosensitive blue product is obtained with $\lambda_{max.}$ about 655 mμ, shifting within 30–40 sec. to 664 mμ. Meunier and Vinet[2] had suggested that the source of the blue colour in the similar reaction of vitamin A is the passage of an electron from vitamin A to antimony chloride, to form a vitamin A cation; the greatly increased resonance associated with the electric charge introduced into the conjugated system of alternate single and double bonds causes the great enhancement of colour and large displacement of absorption toward longer wave-lengths.

These suggestions raised the question whether opsin might contain a metal ion which acts similarly upon the attachment of retinene.

Morton and his colleagues have made extensive studies of the occurrence of trace metals in eye tissues, including retinas. Copper and zinc were found primarily in the black tissues of the eye, associated apparently with melanin – protein complexes; only moderate amounts occurred in the retina[3]. In cattle, the retina is particularly rich in manganese, but the outer segments of the rods which contain the rhodopsin have less of this metal than the other retinal tissues[4].

The particular problem in the present instance is to determine whether rhodopsin (opsin) itself contains a trace metal, and for this, of course, it is necessary to remove all contaminating ions. The de-ionization of solutions with ion-exchange resins is now a well-known procedure. Ordinarily, such resins induce

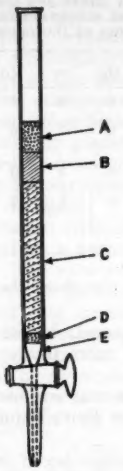

Fig. 1. Arrangement of mixed ion-exchange resins modified from Dintzis (ref. 5). The resins were mounted in a burette in the following order: (*A*) 2 ml. of 'IR-120' in the ammonium cycle form; (*B*) 2 ml. of 'IRA-400' in the acetate cycle form; (*C*) 10 ml. of a mixture of 14 volumes of 'IR-120' in the hydrogen cycle form and 36 volumes of 'IRA-400' in the hydroxyl cycle form; (*D*) about 0·2 ml. of 'IR-120' in the hydrogen cycle form; and (*E*) a plug of glass wool. Both resins employed were the standard 9–10 per cent cross-linkage, 20–50 mesh (Rohm and Haas)

sufficiently high alkalinities or acidities to denature proteins, but Dintzis[5] has devised a combination of resins, variously treated, which avoids this difficulty. Recently, Albrecht[6] used a column of such mixed-bed ion-exchange resins to remove ions from solutions of cattle rhodopsin, and found that this treatment, while removing inorganic ions and small-molecular peptides, does not alter the absorption spectrum of rhodopsin or its regenerability after bleaching.

In the present experiments the same procedure was used to prepare ion-free cattle rhodopsin. All operations were carried out in red light to avoid bleaching. Rhodopsin was prepared from the outer segments of cattle rods, separated from the remaining retinal tissues by differential centrifugation, and pre-extracted with aqueous buffer and petroleum ether, as previously described[7]. At a late step in preparation the buffer solution used to wash the rod residues was replaced by ion-free water to remove the bulk of the salts. The rhodopsin was then extracted with 2 per cent digitonin solution. Its purity was estimated optically through the ratio of extinctions at 400 and 500 mμ (E_{400}/E_{500}); the lower this index, the purer is the preparation. Pure cattle rhodopsin has E_{400}/E_{500} about 0·22. The concentration of rhodopsin was determined from its known[8] molar extinction coefficient at 500 mμ, namely, 40,600.

The design of the resin column is shown in Fig. 1. The column was held for at least one hour at 4° C., and then washed by running ion-free water through it at the same temperature. Since the cattle rhodopsin is dissolved in 2 per cent digitonin solution, this was the eluent used in the procedure. Ion-free digitonin solution was prepared initially by passing 2 per cent digitonin over the mixed bed of resins represented at *C* in Fig. 1. After this treatment the digitonin solution had an electrical conductivity less than $5·0 \times 10^{-6}$ mho.

About 15 ml. of such ion-free 2 per cent digitonin was first run through the column at a rate of flow of 0·5 ml./min. Effluents were collected in 3-ml. aliquots. Usually the fourth fraction was set aside as the control digitonin solution for the metal analysis. At the moment when the last of the digitonin left the top of the column, 4 ml. of rhodopsin solution was pipetted on to the column. When this had entered the column, an additional 15 ml. of ion-free digitonin solution was introduced from a pipette and allowed to run through, always at a constant rate of flow. The effluent samples containing the rhodopsin were identified spectrophotometrically, and through the observation that they possess a slightly higher electrical conductivity than ion-free digitonin solution.

After a first preliminary trial, two further rhodopsin solutions were prepared and purified to the limits of these procedures. Their characteristics are shown in Table 1. The second of these solutions was less contaminated with extraneous material absorbing in the ultra-violet than the first, as shown by the lower E_{400}/E_{500} ratio; and it had also a lower specific conductivity. In both cases the *p*H of the de-ionated solutions was 5·2–5·3, close to the isoelectric point of cattle rhodopsin[9].

The metal analyses were performed at the Biophysics Research Laboratory of the Peter Bent Brigham Hospital in Boston, by methods of quantitative emission spectrography described elsewhere[10]. The samples were ashed at 450° C., and dissolved in 6 *N* hydrochloric acid. Spectral line emission was excited with a high-voltage copper spark; for this reason copper itself was not measured. The spectrograph was a 21-ft. Wadsworth mounting equipped with a grating with 15,000 lines/in. and having a reciprocal linear dispersion of 518 A./mm. Eastman No. 103–0 photographic plates were employed, and the spectral lines were measured and corrected for background emission with a microdensitometer (Jarrell-Ash). The procedure was calibrated with spectroscopically pure chemicals obtained from Johnson Matthey and Co., Ltd.

The results of these analyses are shown in Table 2. For each of them 2 ml. of the preparations described in Table 1 were used. Except for aluminium, small amounts of which apparently are carried into these

TABLE 1. PROPERTIES OF TWO RHODOPSIN SOLUTIONS PURIFIED BY PASSAGE THROUGH MIXED-BED ION-EXCHANGE COLUMNS
(1) Ratio of extinctions at 400 and 500 mμ, a measure of optical purity; (2) extinction at 500 mμ, and below it, in parenthesis, the molar concentration of rhodopsin; (3) electrical conductivity in reciprocal ohms; (4) ratio of electrical conductivity before and after de-ionization on the column; (5) *p*H of the final solution

	1 E_{400}/E_{500}	2 Extinction and (molar concentration)	3 Conductivity (mho)	4 Decrease of conductivity through de-ionization	5 *p*H
Rhodopsin (I)	0·36	1·375 ($3·39 \times 10^{-5}$)	$9·88 \times 10^{-6}$	1/14·8	5·25
Rhodopsin (II)	0·25	1·85 ($4·56 \times 10^{-5}$)	$5·95 \times 10^{-6}$	1/29·5	5·25
Digitonin control	—	—	$5·0 \times 10^{-6}$	1/2·85	6·3

Table 2. Metal Analyses of Rhodopsin Solutions De-ionated by Passage through a Mixed-bed Ion-exchange Column
In each case 2 ml. of rhodopsin solution was ashed and analysed. Results are expressed as μgm./ml. sample as measured, and in the summary rows the corresponding ion equivalents per litre are given for comparison with the concentration of rhodopsin in moles per litre stated

Sample	Zn	Ni	Cd	Fe	Mn	Cr	Ca	Al	Mg	Sr	Mo	Co	Ba	Pb
Rhodopsin (I) ($3{\cdot}39 \times 10^{-5}$ mol./l.)	0·8	0	0	0·9	0	0	0	0·3	0	0	0	0	0·02	0
Digitonin control	0·6	0	0	0·6	0	0	0	0	0	0	0	0	0·09	0
Net content (ion equiv./l.)	$3{\cdot}1 \times 10^{-6}$			$5{\cdot}5 \times 10^{-6}$				*						
Rhodopsin (II) ($4{\cdot}56 \times 10^{-5}$ mol./l.)	0	0	0	0	0	0	0·3	1·5	0	0	0	0	0·02	0
Digitonin control	0	0	0	0	0	0	0·19	0·05	0	0	0	0	0·01	0
Net content (ion equiv./l.)							$2{\cdot}5 \times 10^{-6}$	*					$7{\cdot}3 \times 10^{-6}$	

0, Not detected.
* The values for aluminium are probably spurious, this metal having entered with the use of alum during the preparation.

rhodopsin preparations through the use of alum to 'tan' the rod outer segments, no other metal ion measured proved to be present in concentrations approaching the molar concentration of rhodopsin. Zinc and iron, found in traces in preparation I, were not detectable at all in the purer preparation II. The latter contained a trace of calcium which did not appear in preparation I. A trace of barium appeared in preparation II, but did not seem at all significant, both because it was negligible in amount, and because in preparation I more barium was found in the control digitonin solution than in the rhodopsin. Copper, as indicated, was not measured because a copper spark was used to excite emission. Of the elements that were measured, it seems clear that none exists in cattle rhodopsin in significant amounts.

These experiments offer no evidence for the participation of a metal ion in the structure of rhodopsin. Probably, therefore, there is no need to invoke the action of a metal ion in attempting to account for the chromophoric properties of retinene in any of the known visual pigments. Another mechanism that has recently been proposed, based entirely on organic structures, appears more likely to account for these properties[11].

This investigation was supported in part by funds from the Rockefeller Foundation and the U.S. Office of Naval Research.

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NEW VARIANT OF HUMAN FŒTAL HÆMOGLOBIN

SEVERAL variants of the normal adult hæmoglobin *A* have been recognized. Furthermore, recent reports[1,2] indicate the existence of variants of the normal human fœtal hæmoglobin *F*.

In a paper electrophoretic study of the hæmoglobin from newborn infants, one sample (the 140th of this survey), in addition to the usual pattern *F* + *A*, also contained a smaller component of less anodic mobility than *F* (Fig. 1*a*). Comparison with known hæmoglobin variants at *p*H 8·0–8·6 disclosed that this component is slower than hæmoglobin *S* and only slightly faster than *E* and A_2 (Fig. 1*b* and *c*). At *p*H 6·7 (phosphate buffer, Γ/2 0·1) this fraction moved rather like *S*.

By agar electrophoresis[3] only two spots, corresponding to the positions of hæmoglobins *F* and *A*, were obtained. Since this technique is very adequate for the detection of small amounts of hæmoglobins *S* and *C*, such as might have been present at birth, the absence of an additional spot anodically to *A* further excludes the presence of either *S* or *C*.

So far hæmoglobin *O* is the only variant known to occupy a position intermediate between *E* (and A_2) and *S* at alkaline buffer[4]. Comparison of the component under study with *O* disclosed that both are of similar mobility (Fig. 1*d*). Hæmoglobin *O*, however, can also be demonstrated on agar, where it occupies a position anodically to *A* (personal communication from Dr. Lie-Injo, confirmed by our comparisons); this property of *O* distinguishes it from the fraction described here.

Starch electrophoresis at *p*H 8·6 resulted in a pattern similar to the one obtained on paper. Eluates of the isolated fractions were concentrated and sub-

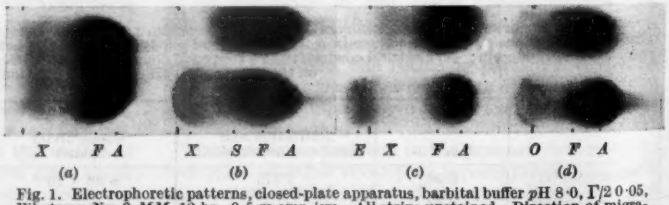

Fig. 1. Electrophoretic patterns, closed-plate apparatus, barbital buffer *p*H 8·0, Γ/2 0·05, Whatman No. 3 *MM*, 12 hr., 0·5 m.amp./cm. All strips unstained. Direction of migration, left to right. (*a*) Sample 140, containing fraction *X* in addition to *A* + *F*; (*b*) above, artificial mixture containing *A*, *F* and *S*; below, sample 140; (*c*) above, sample 140; below, hæmoglobin *A* + *E*; (*d*) above, sample 140; below, hæmoglobin *A* + *O*

jected to electrophoresis again on paper; the slow fraction was very pure, containing only a small amount of *F*. Agar electrophoresis of this fraction revealed only one spot at the position of *F*; such a position of the isolated component can also serve to distinguish it from two other hæmoglobins, which on paper occupy neighbouring places: on one hand *D*, which does not separate[3] from *A*, and on the other A_2, which according to our observations also does not separate from *A* on agar.

The alkali denaturation rate of the isolated slow fraction was measured by a technique adapted from Jonxis and Visser[5]. The rate obtained was similar to that of hæmoglobin *F* from cord blood and to that of the fraction containing mainly *F* of the same electrophoretic separation of sample 140 (Fig. 2).

The ultra-violet spectrum of the fraction under study, following starch electrophoresis of hæmolysates appropriately prepared[6], was very similar to that obtained for hæmoglobin *F* as regards the tryptophan band (Fig. 3).

This sample of cord blood contained 18·3 per cent of the abnormal fraction. Over the ensuing fifteen weeks the abnormal fraction diminished progressively to 2·2 per cent; a parallel diminution of the total alkali-resistant pigment from an initial 60 per cent to 6 per cent was observed.

The newborn presented no clinical or hæmatological abnormality. Of the parents the father was unknown and only the mother was available for study: she was normal.

Our findings suggest that this is another variant of fœtal hæmoglobin: it is similar to hæmoglobin *F* as regards progressive disappearance within the first months postnatally, alkali denaturation-rate, ultra-violet spectrum, and mobility on agar, but definitely distinct from *F* on paper and starch electrophoresis. It is interesting to note that an increased resistance to alkali and an ultra-violet spectrum similar to that of *F* were reported for the fœtal variant 'Bart's'[2].

The possibility should be considered that this variant represents the early normal embryonic hæmoglobin, the existence of which has been suggested by other investigations[7–9]; should this be the case, it must be admitted that in the present instance the early embryonic variant persisted beyond birth. However, the embryonic hæmoglobin of Drescher and Künzer differed from *F* by a definitely faster denaturation-rate[7], while the hæmoglobin of Halbrecht and Klibanski, although slower than *F* on paper, could not be clearly separated from the latter in spite of a prolonged electrophoresis[9]. Furthermore, the mobility of the present fraction was obviously different when compared with hæmoglobin from a 15-week-old fœtus.

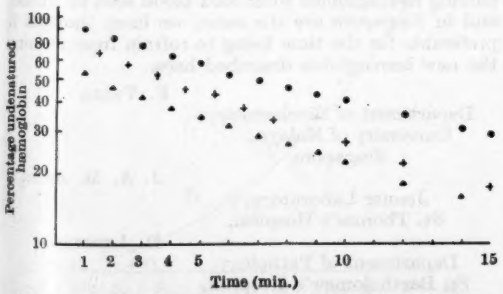

Fig. 2. Alkali denaturation-rate, final concentration of sodium hydroxide 0·05 *M*. Ambient temperature about 30° C. Spectrophotometer Zeiss *PMQ II*, wave-length 576 mμ. +, Normal cord blood; ●, fraction *X* from sample 140; ▲, fraction containing mainly *F* from sample 140

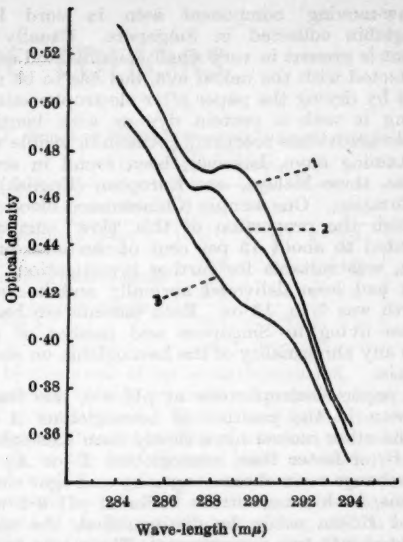

Fig. 3. Ultra-violet spectrum at phosphate buffer, 0·03 *M*, *p*H 6·3, of hæmoglobin solutions. Slit width 0·1 mm., 1 cm. cuvette. (1) Cord blood containing 75 per cent of hæmoglobin *F*; (2) fraction *X* from sample 140; (3) hæmoglobin *A*

The tentative name 'Alexandra' is suggested for the fœtal hæmoglobin described here.

We are indebted to Dr. Lie-Injo Luan Eng, of Djakarta, for supplying samples of hæmoglobin *E* and *O*. We also wish to thank Dr. Gnafakis of the Department of Obstetrics and the staff of the Pædiatric section of the Alexandra Maternity Hospital for helpful collaboration. The Department of Therapeutics, University of Athens, placed at our disposal the spectrophotometer used in this study.

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WHEREAS numerous variants of adult human hæmoglobin (*A*) have been described, there have been few descriptions of hæmoglobins which might be considered variants of the fœtal pigment (*F*)[1,2]. These were concerned with 'fast moving' hæmoglobins, which, on paper electrophoresis at alkaline *p*H, moved towards the anode faster than hæmoglobin *A*. The present report is concerned with

a 'slow-moving' component seen in cord blood hæmoglobin collected in Singapore. Usually this pigment is present in very small amounts and cannot be detected with the naked eye, but has to be made visible by drying the paper after electrophoresis and staining it with a protein dye or with benzidine (pseudo-peroxidase reaction). Amounts visible without staining have, however, been found in several Chinese, three Malays, one European (English) and one Eurasian. One sample (Chinese cord blood 675), in which the proportion of this 'slow' component amounted to about 15 per cent of the total hæmoglobin, was suitable for further investigation. The infant had been delivered normally and its weight at birth was 7 lb. 13 oz. Both parents are healthy Chinese living in Singapore and neither of them shows any abnormality of the hæmoglobin on electrophoresis.

On paper electrophoresis at *p*H 8·6, one fraction was seen in the position of hæmoglobins $A + F$, and the other moved more slowly than hæmoglobins S or D, or faster than hæmoglobins E or A_2. On ion-exchange resin chromatography and agar electrophoresis, both using citrate buffer at *p*H 6·2 where A and F can easily be distinguished, the sample separated into two components. The major fraction occupied a position similar to that of hæmoglobin F, and the minor fraction one similar to that of hæmoglobin A_2. The two fractions were eluted, and on paper electrophoresis at *p*H 8·6 it was seen that the major fraction was composed of hæmoglobin F and the new hæmoglobin. Thus on paper electrophoresis at *p*H 8·6 the new hæmoglobin resembles hæmoglobin O, which by this technique migrates between S (or D) and E (or A_2), and on chromatography and agar electrophoresis at *p*H 6·2 it resembles hæmoglobin F and unlike O moves faster than A.

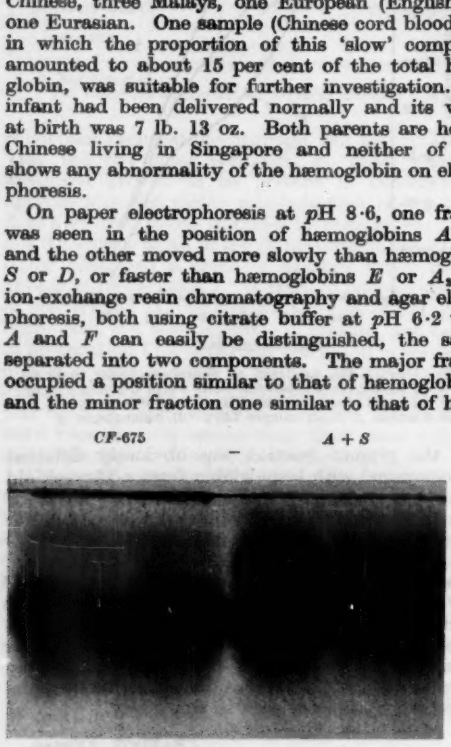

Fig. 1. Comparison of the hæmoglobin from Chinese cord blood *CF*-675 with a hæmoglobin $A + S$ control by paper electrophoresis at *p*H 8·6, hanging strip technique. The paper strip was dried and photographed unstained. (1) Line of application; (2) slow-moving component in *CF*-675; (3) hæmoglobin S; (4) hæmoglobin $F + A$ in *CF*-675; (5) hæmoglobin A

Fig. 2. Comparison of the hæmoglobin from Chinese cord blood *CF*-675 with a control containing hæmoglobins A_2 and F and an increased amount of hæmoglobin A_2. Technical details as for Fig. 1. (1) Line of application; (2) hæmoglobin A_2; (3) slow moving component in *CF*-675; (4) hæmoglobin A_2 (and F)

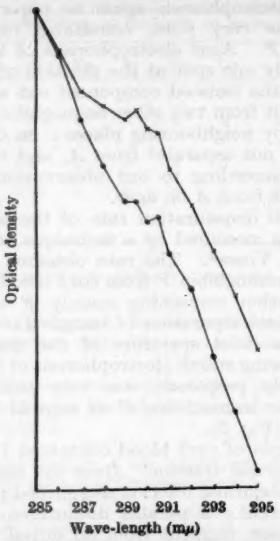

Fig. 3. Ultra-violet spectrum of the slow component isolated from Chinese cord blood *CF*-675 and of purified hæmoglobin from human cord blood containing 80 per cent F and 20 per cent A. ×—×, Cord blood control; O—O, Chinese cord blood *CF*-675 slow component

It was unfortunate that the hæmoglobin solution had to be transmitted in the carbonomonoxy form and the alkali-denaturation properties of the isolated pigment could therefore not be determined. The ultra-violet spectrum was determined after elution from paper after electrophoresis. It showed a tryptophan fine-structure band of the fœtal hæmoglobin type.

We reported the observation of a slow-moving fœtal component to Dr. Ph. Fessas, who kindly informed us that he had observed a similar or perhaps identical abnormal fœtal hæmoglobin at the Alexandra Hospital in Athens which he proposed to call hæmoglobin 'Alexandra'. As it is very likely that the slow-moving hæmoglobins from cord blood seen in Athens and in Singapore are the same, we have thought it preferable for the time being to refrain from naming the new hæmoglobin described here.

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LETTERS TO THE EDITORS

PHYSICAL SCIENCES

Smoke Emission of Low-Temperature Chars

It has been accepted in the past that coals are effectively smokeless when they contain less than 20 per cent of volatile matter. Thus the approved smokeless fuels include low-volatile steam coals ranging in volatile content from 9·1 to 19·5 per cent and manufactured fuels of volatile content near or less than the lower limit of this range. Consequently, the assumption is sometimes made that, in order to be smokeless, coal products must have their volatile content reduced to less than 20 per cent.

This assumption is unjustified. Early work by Piersol[1] showed that devolatilization of certain American coals gave chars which were smokeless although their volatile contents exceeded 20 per cent. At the Coal Research Establishment a similar effect has been found for high-volatile British coals which were devolatilized by fluidized carbonization. Briquettes made from a char of 33 per cent volatile content emitted less smoke than a steam coal of 18 per cent volatile content, and when made from a char of about 23 per cent volatile content they were completely smokeless.

The smoke emission of a series of chars of different volatile contents and of coals covering a similar volatile range has been investigated. From both coals and chars, the smoke consisted mainly of tar-like pyrolysis products which had escaped complete combustion. The smoke emission decreased with decreasing volatile content, but was always less for a char than for a coal of the same volatile content. Nevertheless, as shown by Fig. 1, a common relationship for coals and chars was found between the smoke yield on combustion and the tar yield as measured by a Gray–King assay. It is concluded that the smoke emission of coals and chars is mainly determined by the yield of tar on carbonization. A char of 23 per cent volatile content is smokeless because its yield of tar is small. This is mainly due to the fact that during the preparation of the char, a considerable amount of tar has already been evolved from the parent coal.

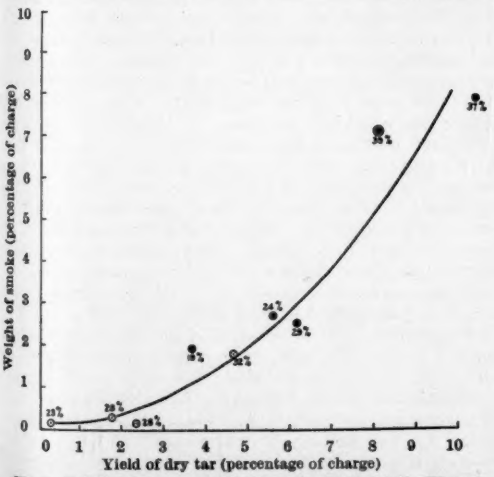

Fig. 1. Relation between weight of smoke and tar yield. Figures adjoining points are volatile matter contents (percentage d.a.f.). ●, Coals; ⊙, chars

Table 1. Yields of Products from the Carbonization of Cannock Wood Coal
(Percentages of dry coal)

Carbonizing conditions	Char	Tar	Liquor	Gas
Coal carbonized to 425° C.	87·7	6·7	3·8	1·4
Char recarbonized to 550° C.	77·8	1·8	4·0	4·0
Total yields from two-stage carbonization	77·8	8·5	7·8	5·4
Coal carbonized directly to 550° C.	76·8	9·8	7·1	6·2

A second factor, however, also contributes to the low yield of tar from a smokeless char. When a high-volatile coal was carbonized at 5 deg. C. per min. to 425° C. to give a smokeless char, the yield of tar was 6·7 per cent by weight. Carbonization of the coal under the same conditions but to 550° C. (a temperature sufficiently high for the maximum yield of tar under these carbonizing conditions) gave 9·8 per cent yield of tar. It might therefore be expected that the yield of tar obtained by carbonizing the smokeless char to 550° C. would equal the difference, namely, 3·1 per cent. The yield obtained (1·8 per cent) was significantly lower. Moreover, as shown in Table 1, the decrease in yield of tar was accompanied by a corresponding increase in the yield of char, the yields of liquor and gas not being significantly affected. These results show that when carbonization is carried out to a fixed upper temperature in two stages, some of the intermediate pyrolysis products, which would have been evolved as tar in a single-stage carbonization to that temperature, are converted into char. This effect is related to the observation of other workers[2–4] who, studying different aspects of coal pyrolysis, have also observed that when the upper temperature limit of carbonization is fixed, the yield of tar or coke depends on the carbonizing conditions. It is concluded that certain pyrolysis products of coal can either be evolved as tar or, if they are left in contact with the heated coal, undergo further reactions—possibly polymerization or condensation—to give a solid product.

Thanks are due to the National Coal Board for permission to publish this communication, a full account of which is being published elsewhere.

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Precipitation on a Dislocation

We have recently made a study of the effect of heat treatment on silicon crystals containing up to 10^{17} aluminium atoms/c.c. After heating for several hours at a temperature of 1,250° C., transmission infra-red microscopy reveals the presence of a precipitated second phase within the crystals. In samples free of dislocations, these precipitates are needle-shaped and located at random sites, whereas in crystals with a dislocation density between 10^3 and 10^4 cm.$^{-2}$, the precipitation occurs almost entirely along the dislocation lines. These latter precipitates invariably appear as discrete particles strung out along the lines (Fig. 1).

A possible mechanism for the growth of the precipitates is suggested by the observation that these are discrete and lie along the dislocation lines, that is, the impurities migrate to the dislocation and then flow rapidly down the core to sites where precipitates have nucleated. Such a possibility has previously been suggested by Bilby[1] to explain the observed persistence of the $t^{2/3}$ law in some strain-aging and internal-friction experiments[2]. Bilby considers that, even in the later stages, the impurities migrate to the dislocation under predominantly drift forces. We consider, however, that the drift flow across any internal surface within the crystal is small compared with the diffusion flow. Such a proposition has recently been used to discuss the growth of an impurity atmosphere near a dislocation[3]. Since the boundary condition adopted in that treatment enforced zero net diffusion flow, the growth of the atmosphere was due entirely to the small drift perturbation.

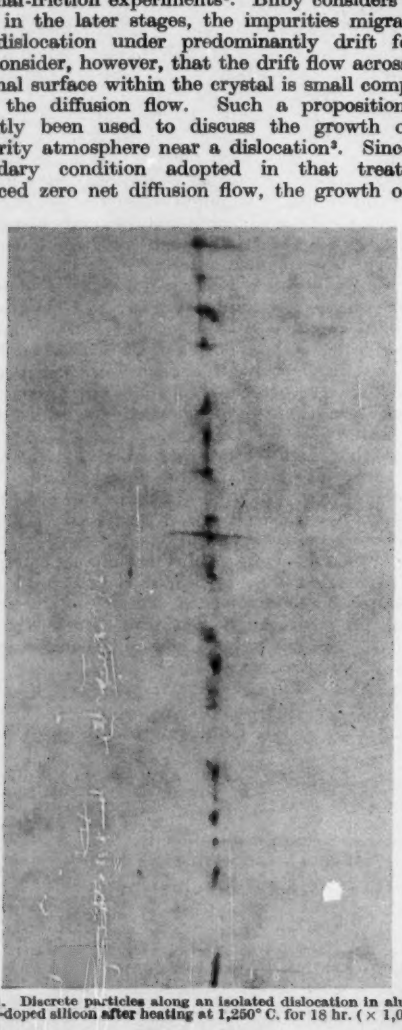

Fig. 1. Discrete particles along an isolated dislocation in aluminium-doped silicon after heating at 1,250° C. for 18 hr. (× 1,000)

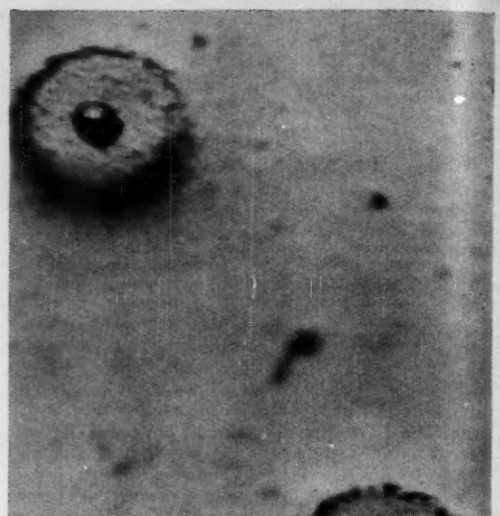

Fig. 2. Cylindrical p–n junction around single dislocations (× 2,200)

An essential feature of our model was that the impurities, in the core region, had extremely high mobility. The concept of high diffusion rates down the dislocation core at a later stage, when the impurity atmospheres have condensed locally to form discrete precipitates, is thus consistent with this model. Once such precipitates have nucleated, the relevant boundary condition is zero impurity concentration at the dislocation core. We assume here that the precipitates occupy only a small fraction of the total length of dislocation line. With this boundary condition, there will be a net diffusion flow across any internal surface, and hence to a first approximation drift flow may be neglected. The number of impurities reaching the core in time t with this boundary condition has been recently evaluated by F. S. Ham (private communication), although his reason for adopting this boundary condition is the opposite of ours, since he considers that impurity atoms are completely immobilized on reaching the centre of the dislocation. The number of atoms arriving at the dislocation in time t is a function of the dimensionless variable $m = Dt/r_0^2$, where D is the diffusion constant and r_0 is the radius of the dislocation core. The variation closely resembles $m^{2/3}$ for $0{\cdot}1 \lesssim m \lesssim 20$. It is interesting to note that this variation is similar to that found in strain-aging experiments in steels containing small concentrations of carbon and nitrogen[2]. To obtain reasonable agreement, r_0 must be chosen in the range 20 A. $< r_0 <$ 60 A.; this range includes the value of r_0 obtained in our previous calculation for the growth of a Cottrell atmosphere[3].

If the precipitation process is governed primarily by drift flow, then one would expect an asymmetrical distribution of concentration around the dislocation core, due to the angular dependence of the potential field[4]. Our assumption, however, of the predominance of pure diffusion flow would lead to a radially symmetrical distribution. Silicon provides a unique opportunity to distinguish between these two possibilities. The flow of aluminium (a *p*-type impurity) to form such strings of precipitates as shown in Fig. 1 clearly depletes the region in the neighbourhood of each dislocation. Thus a *p–n* junction would be produced in this region if the crystal initially contained both phosphorus and aluminium, the concentration of the latter being slightly in excess, since no precipitation of phosphorus occurs. The trace of such a *p–n* junction is a line of equal aluminium concentration, and may be revealed as a step on the surface of the crystal by using the Dash etch[5]; at the same time, an etch pit is produced at the point of emergence of the dislocation line. Examples of this are shown in Fig. 2. The *p–n* junctions are seen to be circular and concentric about the etch pits, supporting our argument for radially symmetrical flow to the dislocations. A more stringent test would be to examine this contour after much shorter diffusion times; however, the technique is only feasible when the radius of the *p–n* junction is greater than the radius of the etch pit.

We wish to thank our colleagues in this Laboratory for support in carrying out this work. Thanks are also due to Dr. T. E. Allibone, director of the Research Laboratory, Associated Electrical Industries, and to the Admiralty, for permission to publish this communication.

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Neutron Diffraction at a High-Flux Reactor

Up to the present, all neutron diffraction studies in Great Britain and practically all structural studies elsewhere have been carried out with neutron beams from reactors which have a peak flux of a few times 10^{13} neutrons per sq. cm. per sec.; for example, at Harwell the reactor Bepo has been used for this work. We have now made preliminary measurements with a spectrometer at the research reactor Dido, where a peak unperturbed flux of about 5×10^{13} neutrons per sq. cm. per sec. is available. We achieve in practice an increase of about twenty times the intensity of our neutron beam, and this increase is available for reducing proportionately the size of the sample for study. The advantage of this, for solid-state studies with neutron beams, can be seen in two ways.

For materials which are available only in polycrystalline or powder form it was previously necessary to use about 5 c.c. of material in order to attain reasonably large diffracted intensities and adequate angular resolution. The same result is now obtained with a volume of 0·3 c.c. This quantity of diamond powder, often used as a standard substance, has given peak intensities of 560 and 460 counts per min. for the (111) and (220) reflexions respectively on a background of 40 counts. Apart from the more obvious advantages of using small samples, there is an important prospective gain for magnetic materials: it will become a practical proposition to make samples with the iron isotope, iron-57, which has a nuclear scattering amplitude less than a quarter of that of ordinary iron and which is correspondingly less troublesome when distinguishing between the contributions from nuclear and magnetic scattering.

For single crystal investigations, a reduction in size by twenty times enormously increases the range of materials which can be obtained in crystals of sufficient size to be studied. Over the past few years structural studies have been made at Harwell using single crystals of many chemical compounds. The average size of crystal used has been 160 c. mm.; thus this now becomes about 8 c. mm., or a fragment with an edge of about 2 mm. each way. We quote as an example a result for potassium bromide which serves as a standard substance.; a cleaved block with a volume of 5 c. mm. gave a peak count of 7,000 neutrons per min. for the (200) reflexion. As well as widening the range of materials which can be studied as single crystals, reduction of size brings the important additional advantages that corrections for secondary extinction will be much less significant, and crystal preparation using selected isotopes, for application of the isomorphous replacement method of structural analysis, will become practicable.

A description of the spectrometer, with an account of the problems posed by the higher flux, will be published elsewhere.

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Tensile Strength of Asbestos

Asbestos is the generic name for those silicate minerals which cleave naturally into fibres, the three important species being chrysotile (white asbestos), crocidolite (blue asbestos) and amosite. This unique mineral structure lends itself better to measurements of tensile strength than do the more common minerals with isotropic or platy structures, which are extremely difficult to prepare in the form of adequate tensile specimens, although measurements on mica have been reported[1].

Very high values may be predicted for tensile strengths of silicates, from consideration both of the strengths of the stable silicon–oxygen chains or sheets which characterize these minerals, and of the cohesive pressures which exist in solids, and which must be equalized in order to break a specimen. An explanation for the discrepancy, which exists between the estimated tensile strengths of solids and the highest values usually obtained in practice, was given by Griffiths[2,3], who said in effect that the high strengths calculated were correct and that the tensile measurements were wrong. The tensile strength of asbestos has been measured by Syromjatnikoff[4] and by Badollet[5], who have reported various values, but

none exceeding 330,000 lb./in.², which is a high value for a tensile strength (steel piano wire is usually quoted as having a strength of 350,000 lb./in.²), but is only a fraction of the value to be expected.

We have carried out a large number of tensile measurements (including modulus determinations), on asbestos of different types and have found that results may be obtained which are much higher than any yet reported. By taking high-speed photographs during a measurement, we have also been able to demonstrate the type of failure which occurs when asbestos fibres break. Our initial work indicated that, in order to obtain accurate results, the cross-sectional area of the fibres should not exceed 10^{-5} cm.², this being calculated from the specific gravity, length and weight of the specimens determined on a microbalance with a sensitivity of 1 μgm. The samples were mounted on a slip of paper on two spots of 'Seccotine' and these covered with small squares of paper. In this way, a good grip for the jaws of the tensometer was provided, and there was no tendency for the fibres to slip through the glue. The paper was carefully cut through just before the stress was applied. The tensometer consisted of a modified 'Chainomatic' balance: the strain was determined by observing the pointer with a microscope.

Our investigation consisted of making a series of determinations of tensile strength for various lengths of fibre. Average results, as well as a maximum strength obtained at each length, are shown on Table 1. Each average strength reported is the mean of not less than 25 results, it being found that a larger number of tests did not appreciably alter the progressive average. Tests carried out on the same samples, over a period of two years, gave repeatable results to within a few per cent.

Table 1. Tensile Strength

Sample	Length of sample (cm.)	Ultimate tensile strength (10^3 lb./in.²)		Coefficient of variation (per cent)
		Average	Maximum measured value	
Amosite (Transvaal)	3·5	148	247	34·6
	2·5	146	248	35·0
	1·7	172	269	29·2
	1·0	192	283	32·5
	0·5	203	287	24·7
Crocidolite (Cape Province)	3·5	469	740	29·4
	2·5	470	735	31·3
	1·0	540	815	23·0
	0·5	585	870	24·5
	0·2	605	876	20·3
Chrysotile (Arizona)	3·5	186	314	34·8
	2·2	208	346	34·9
	1·5	236	425	40·0
	1·0	312	470	29·9
	0·5	309	596	34·7
	0·2	320	820	56·8
Chrysotile (Thetford, Canada)	2·5	281	604	34·5
	1·5	321	670	41·0
	1·0	355	704	41·1
	0·5	414	789	33·4
	0·2	436	824	31·3

Table 2. Young's Modulus

Sample	Length of sample (cm.)	Young's modulus (10^3 lb./in.²)	Coefficient of variation (per cent)
Amosite (Transvaal)	3·5	23·6	8·7
Crocidolite (Cape Province)	3·5	27·1	6·8
Chrysotile (Arizona)	3·5	23·2	9·9
Chrysotile (Thetford, Canada)	2·5	23·1	10·6

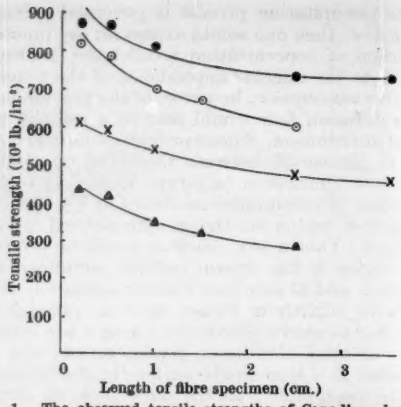

Fig. 1. The observed tensile strengths of Canadian chrysotile (⊙, maximum; △, mean) and of South African crocidolite (●, maximum; ×, mean) plotted against length of fibre specimen

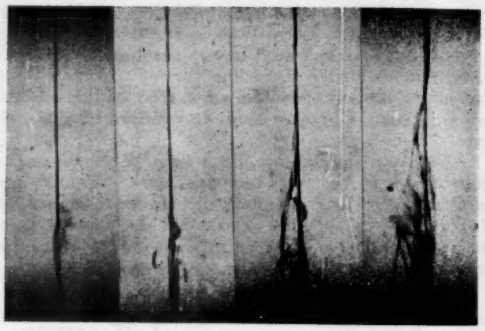

Fig. 2. Canadian chrysotile fibre breaking under tension. The intervals between each of the four exposures are 16·5, 32 and 44 thousandths of one second, respectively

Relatively long fibres were used to obtain values of Young's modulus, which are given in Table 2. For amosite and crocidolite asbestos, the plots of load versus extension were straight lines up to the breaking point. For chrysotile asbestos, plastic deformation occurred when the tensile stress exceeded about 80 per cent of the breaking load; the straight portions of the curves were used for calculating Young's modulus.

The tensile determinations show that in the most favourable circumstances, and using very short fibres, tensile strengths of approximately 900,000 lb./in.² may be obtained, approaching the value of 1,500,000 lb./in.², which Orowan has suggested[6] for solids of this type (Fig. 1). The photographs (Fig. 2) demonstrate the mechanism of failure during the tests, which is comparable with that of mica, reported by Orowan[7]. Amosite gave a more brittle and sudden fracture which could not be resolved on our photographs.

Thus it appears that failure usually begins at a surface flaw but that the strain is relieved by rupture of the relatively weak interfibrillar bonds, thus producing broken fibres at that point, but exposing the surfaces of fresh fibres which may begin to fail at quite a different place. The possibility of failure beginning at surface flaws is clearly reduced as the length of the specimen is decreased, thus enabling

higher tensile strengths to be measured on shorter specimens.

We are grateful to Prof. E. Orowan, of the Massachusetts Institute of Technology, for helpful comments, and to the directors of the Cape Asbestos Co., Ltd., for permission to publish these results.

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Simulation of Lunar Craters: a Blow-hole Theory

Recent reports of volcanic activity on the Moon[1] have stimulated us to repeat an accidental observation made many years ago by one of us (A. G. G.). During rapid evacuation of a quantity of magnesium carbonate in a flask, a number of blow-holes appeared as the occluded gas escaped, leaving a pattern of rings, some with central 'pimples', closely resembling lunar craters. In the present work, we have repeated this experiment (Fig. 1). We have also put a quantity of dry powder (sand, salt, magnesium oxide or magnesium carbonate) in a 5-l. flask, which was continuously evacuated; a small flow of air was admitted at the bottom of the flask by a small hole. Various forms of blow-hole were observed. In many cases, a marked ring, with steep inner edge and less steep outer edge, was formed by the fountain of small particles; sometimes, when the air was cut off, a small pimple remained at the centre of the fountain as it collapsed (Fig. 2). The form of the 'crater' varied rather with type of powder, especially its angle of slip, and the depth, and with the rate of flow of gas.

It is known that terrestrial volcanoes may emit large quantities of dust and ash (cf. the fate of Pompeii), but the presence of an atmosphere interferes with the free fall of the particles. On the Moon, with no atmosphere, lower gravity, and probably a dry, 'sandy' surface, formation of the craters, with or without a central peak as the blow-out peters out, seems possible. It should be noted that the escape of gas trapped beneath the Moon's loose 'sandy' surface, with the formation of this type of blow-hole crater, would not necessarily require the high sub-surface temperatures usually associated with volcanic activity.

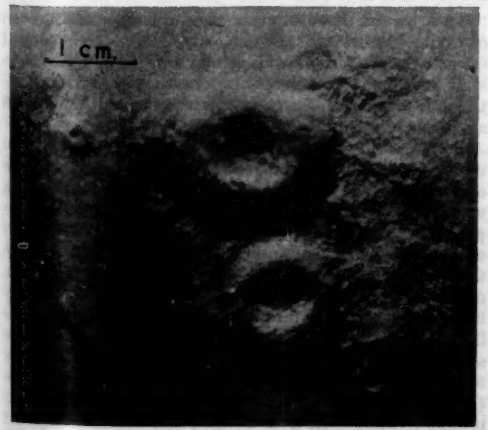

Fig. 1

Fig. 2

The meteoric theory of craters seems unable easily to account for the circular, rather than oval, shape made by the non-vertical fall of a meteorite, or for the very smooth surface of the area within the ring. In our experiments, the region within the craters was usually fairly flat, although the formation of a fluidized bed may account for this, and such a condition seems unlikely on the scale of the lunar surface.

Recent unconfirmed reports[1] of C_2 emission bands near the crater Alphonsus may not necessarily indicate that the gas has a very high initial temperature. It has recently been shown[2] that shock-wave excitation of CO, CO_2 or CH_4 produces C_2 Swan emission. Shock-waves can be produced by a sudden release of pressure, as in the bursting-diaphragm shock tube.

While these theories are speculative, it seems that the possibility of lunar craters being caused by fountains of dust blown out by trapped gas should be considered.

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Microwave Dielectric Properties of Indian Shellac in the 8-mm. Range

Shellac is produced in India after refinement from natural seedlac which contains more than 88 per cent of lac and 4·5 per cent of wax, the remainder being made up of colouring matter, gluten and moisture. Various grades of commercial shellac contain varying percentages of soluble impurities, wax, rosin and moisture. For microwave work a very high degree of purity is needed in dielectric samples. The three grades of shellac, 'Blonde', 'Crown' and 'Granta', manufactured by Angelo Bros., are free from rosin and orpiment and contain only 0·5–0·1 per cent of the insoluble impurities.

They are at present the only samples of the highest degree of purity available and have therefore been used for dielectric measurements in the 8-mm. band. Measurements have also been taken in two other electrical grades used for micanite. The dielectric loss in shellac, grade 'Blonde', is found to be the lowest in the 8-mm. band, and for this grade measurements of loss have also been carried out over a very wide band of radio frequencies.

The microwave dielectric properties of several grades of shellac at radio-frequencies have been reported[1] and the variation of the dielectric loss with temperature has also been studied[2] in three grades of shellac of high purity in the 3-cm. band. The loss factor in the case of shellac lies in the medium range so that the standing-wave technique of Von Hippel[3] is found to be most suitable and accurate. A suitable test bench with a *VX* 357 klystron oscillator, an attenuator and a Hilger standing-wave indicator Type *W*870 with frequency meter and crystal detector were used. The oscillator could operate continuously in the range 8·35–9·16 mm. with a maximum power output of 19·5 MW. The unit was situated in an air-conditioned laboratory and additional air cooling was provided by an external assembly of air blowers, to keep frequency-drift to a minimum. A dielectric cell with a movable shorting plunger was made in the laboratory. The square law response of the crystal, depth of probe penetration and standing wave ratio with the shorting plunger were adjusted in accordance with the standard methods[4].

Wave-guide samples of shellac were made by softening the material, obtained in the form of flakes of high purity, and then moulding it in a die under pressure. The die was kept warm, to prevent entrapping of air bubbles, and only samples free from them were used for these experiments. At least three samples of each grade of shellac of varying thicknesses between $\lambda_d/4$ and $5\lambda_d/4$ were used for measurements of loss, where λ_d is the wave-length in the dielectric. All samples were first dried in an electric oven and then left in a desiccator for 45 hr.: it was found that moisture can be eliminated by this method without detriment to the sample.

The complex permittivity $\chi = \chi' - j\chi''$ has been determined at room temperature (25° ± 1° C.) at 35·65 Gc./s. ($\lambda_0 = 8{\cdot}412$ mm.) and the results are shown in Table 1. χ'' is represented in terms of the tangent of the loss angle, $\tan\delta = \chi''/\chi'$. A correction was also applied to the dielectric constant for clearance errors[5].

Dewaxed 'Blonde' grade of Indian shellac shows the lowest loss in the 8-mm. band. This particularly pure grade is made by a solvent process using cold alcohol, in which the wax is soluble. The measurements of dielectric loss in this grade were carried out over a wide frequency band from 10 kc./s. to 35 Gc./s. to find the peak of the dielectric loss. The *S*-band measurements were made on a shorted coaxial line[6] through the courtesy of Shri Krishnaji in the Department of Physics in the University of Allahabad. The tan δ – log f curve for this grade is shown in Fig. 1.

Table 1. Dielectric Constant and Loss of Indian Shellac in the 8-mm. Band

Grade of shellac	Insoluble impurities	Wax (per cent)	ε' at 25° C.	tan δ 25° C.
'Blonde'	0·1	Nil	2·761	0·0082
'Crown'	0·5	4·5	2·831	0·0379
XL	0·5	4·5	2·790	0·0310
'C Pure'	0·5	2·5	2·790	0·0661
'Granta'	0·5	3·0	2·780	0·0751

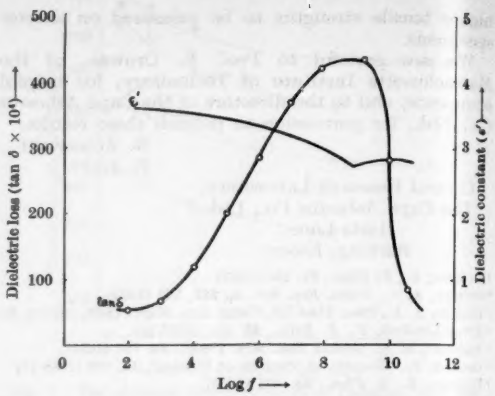

Fig. 1. Tan δ – log f curve of 'Blonde' grade shellac (0·1 per cent)

We are grateful to Dr. K. N. Mathur, deputy director of the National Physical Laboratory, for providing the facilities for this work. One of us (S. S. S.) is also grateful to Dr. D. S. Kothari, scientific adviser to the Ministry of Defence, for permission to work in the National Physical Laboratory.

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CHEMISTRY

Explosion of Transition Metal Co-ordination Compounds

In a recent discussion on the initiation and growth of explosion in solids, Eggert[1] and McAuslan[2] reported on the initiation of explosions by light. Evidence was presented for the photochemical and/or photothermic effects in various nitrides, azides, acetylides and perchlorates.

During an investigation of the photochemical reaction of some transition metal complexes[3], the compounds $[Co(en)_3]_2(S_2O_8)_3$ and $[Cr(en)_3]_2(S_2O_8)_3$ were prepared as part of a programme to discover possible photosensitive systems among the solid co-ordination compounds of the transition elements. Quite accidentally, it was observed that the chromium compound produced an explosion, accompanied by the formation of a copious ash, when ignited by a flame. A systematic examination of this phenomenon showed that the explosion could also be initiated by exposing the compounds to ultra-violet radiation (3650 A.) followed by heating. The chromium compound exploded at 115° C. and the cobalt compound at 120° C.

While attempting to deduce the mechanism of the photosensitivity of these compounds brought about by ultra-violet radiation and heat, a severe explosion occurred as the chromium compound was being irradiated, and perhaps overheated, in a Vycor tube attached to the mass spectrometer. Further investigation showed that the controlled thermal decomposition following ultra-violet radiation resulted in the oxidation of the ligand with the evolution of nitrogen, carbon dioxide and water vapour.

This work was done at the University of Connecticut, Storrs, Connecticut.

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Sealing of Aluminium Oxide Anodic Films

THE formation of boehmite on the surface of anodized aluminium by immersion in boiling water has been investigated by Hart[1]. In particular, studying ammonium borate anodic films on aluminium, he found by electron diffraction that the pseudo-amorphous structure of the surface layer was converted to boehmite, but that this change did not occur when the detached film was immersed in boiling water. Hart therefore suggested that the mechanism of the process was an outward movement of aluminium ions from the metal, passing through the oxide layer, and combining with hydroxyl ions to form boehmite in the pores of the existing oxide layer and on the outer surface.

Similar experimental results were also reported by Kerr[2], again after an electron-diffraction study of ammonium borate anodized films, when it was concluded that boehmite was formed only in the presence of metallic aluminium. Spooner[3], however, making an electron-diffraction study of sulphuric acid anodic coatings, found that conversion of the aluminium oxide layer to boehmite occurred in films attached to, and detached from, their aluminium bases, which confirmed that in this case the process was one of hydration of the existing oxide and did not require the presence of metallic aluminium.

It may therefore be of interest to report that working with boric acid anodic coatings we also found that conversion to boehmite occurs in films, detached from their aluminium bases, when sealed in boiling water.

Aluminium foil (99·99 per cent) of 0·012 mm. thickness was anodized at 550 V. in boric acid solution. After sealing by immersion in boiling water, the anodic film was stripped from the metal using saturated mercuric chloride solution and washed in distilled water. The resulting film was too thick to allow an electron diffraction transmission pattern to be obtained; but it was found that an outer layer, ~100 A. in thickness, could be obtained by evaporating a thin coating of aluminium on to the sealed film while still attached to the foil, and freeing this with a chromic–phosphoric acid solution[4]. An electron diffraction transmission pattern of this exceedingly thin aluminium-supported layer showed the presence of boehmite, the reflexions being compared and found to be in good agreement with published results[5].

An X-ray powder diffraction pattern of the whole film as separated by mercuric chloride, which was carefully wrapped on to a glass fibre, showed a predominantly γ-alumina composition with evidence of only a small amount of boehmite present. In a further study the film was removed from an anodized but unsealed foil, using the mercuric chloride technique, and boiled in distilled water for 20 min. An X-ray powder specimen was prepared as before, and the resultant diffraction pattern again showed the presence of boehmite and γ-alumina. In this case, however, a study of the relative intensities of the X-ray reflexions showed that an appreciable amount of γ-alumina had been converted to boehmite. This suggested that the greater surface area of the detached film had contributed significantly to the extent of hydration.

These results show that water-sealing of boric acid anodic films is a hydration process and occurs independently of the presence of metallic aluminium.

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Electrode Potentials and Compound Formation in the Palladium–Platinum–Hydrogen System

ELECTRODE potentials and electrical resistances of palladium wires alloyed with 5, 10, 20 and 25 per cent platinum have been measured while they absorbed hydrogen (dissolved under a pressure of 1 atm.) from aqueous solutions of 2 *N* sulphuric acid. Apparatus and techniques were similar to those previously employed[1]. The wires were 0·027 cm. in diameter and were prepared by directly alloying the metals. The measurements reported were made on 15-cm. lengths of wire in the cold-drawn condition, which were preactivated by discharging oxygen at their surfaces by electrolysis[2,3]. Potentials differing from zero were positive with respect to a platinum hydrogen electrode in the same solution.

Selected experiments using the method of vacuum outgassing[1,2] indicated that the relative resistance (R/R_0) of the alloys was proportional to the hydrogen content, as has been established in detail for the palladium–hydrogen system[4]. Plots of R/R_0 against electrode potential for the alloys with 5, 10 and 20 per cent platinum revealed that they behaved like palladium, showing the general relationship illustrated by I in Fig. 1*a*, although with increasing platinum content the step *BC* showed increasing departure from the horizontal with respect to the R/R_0 axis. The behaviour of the 25 per cent platinum alloy is shown by II in Fig. 1*a*. As was found for the palladium–hydrogen system, the equilibrium potential (*D* in Fig. 1*a*) is zero with respect to the platinum–hydrogen electrode.

The electrode potentials can be related to the change in free energy $\Delta \bar{F}$ for the reaction:

$$x\mathrm{H} : y\mathrm{Pt} : z\mathrm{Pd} + \tfrac{1}{2}\mathrm{H}_2 \rightleftharpoons (x+1)\mathrm{H} : y\mathrm{Pt} : z\mathrm{Pd}$$

where x, y, and z represent numbers of atoms. Using the relation $\Delta \bar{F} = -n\mathfrak{F}E$ and the experimental value of E, namely, 46·8 ± 0·5 mV., found for point B (Fig. 1*a*) in the palladium–hydrogen system at 30° C., $\Delta \bar{F}$ for the formation of an idealized compound $PdH_{0.5}$ is − 2,158 ± 24 cal./mole of hydrogen, between the limits PdH_r and $PdH_{r+0.5}$, where PdH_r represents the composition at B (that is, the maximum solid solubility of hydrogen in palladium). This compares with $\Delta \bar{F} = -2{,}306 \pm 12$ cal./mole of hydrogen which has recently been determined from gas-phase isothermal measurements[5]. The change in free energy associated with the formation of non-stoichiometric palladium–platinum–hydrogen compounds is also identified with the electrode potential represented by B (Fig. 1*a*) for each palladium–platinum alloy. (The definition of this point was subject to an uncertainty of ± 2 mV. in the case of the 20 and 25 per cent platinum alloys.) Fig. 1*b* shows these free energies of formation per mole of hydrogen, at 25° C., plotted against the platinum content of the alloys.

It has been suggested from previous evidence that a two-phase region analogous to that of the palladium–hydrogen system would not be formed by the absorption of hydrogen in palladium–platinum alloys with more than 5 per cent platinum. However, it is indicated by Fig. 1*b* that a two-phase region may occur in palladium–platinum alloys with less than 25 ± 2 per cent platinum.

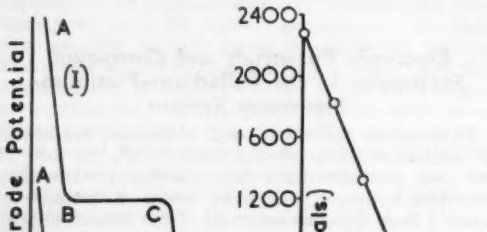

Fig. 1

Hydrogen dissolved in alloys with more than 25 ± 2 per cent platinum should be present only as a primary solid solution and appreciable solubility of hydrogen has been reported in palladium–platinum alloys containing 25–35 per cent platinum[6,7]. The gross dimensional changes of palladium foils which occur when they are repeatedly saturated with hydrogen[8] are possibly associated with the formation and collapse of the non-stoichiometric β-phase palladium hydride. Palladium–platinum alloys containing about 30 per cent platinum may therefore have advantages over pure palladium as diffusion membranes for hydrogen.

Acknowledgment is due to the Mond Nickel Co., Ltd., for providing the palladium–platinum alloys used in this investigation.

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Ferrous and Ferric Complexes with Pyridine 2-Aldoxime

Pyridine 2-aldoxime forms well-defined coloured complexes with ferrous and with ferric ions in aqueous solution. The ferrous complex is violet-red in alkaline solution (with an absorption maximum at 530 mμ), reddish-orange in slightly acidic solution (with a maximum at 515 mμ), and golden-yellow below *p*H 3 (with a maximum at 475 mμ). The ferric complex is reddish-brown in alkaline, neutral and slightly acidic solution (with no absorption maxima in the visible), and yellow in more acidic solution. All the colour changes are reversible.

If this compound had the *syn* configuration (see Fig. 1), then these colour changes are most probably the result of ionization of the OH group. On the other hand, if the molecules are in the *anti* form, then the iron atom in the complex could only be bonded to nitrogen and oxygen, as can easily be verified by examination of atomic models. In the latter case the colour changes will have to be attributed to ionization on the basic unbonded nitrogen of the oxime.

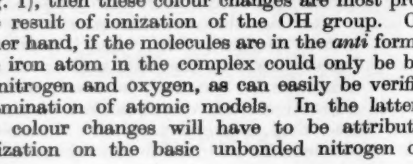

Fig. 1

Recently, Krause and Busch[1] prepared some nickel (II) complexes of this ligand. Drawing the analogy between their system and the corresponding ones with α-α′-dipyridyl and with dimethylglyoxime, they assumed that the nickel atom was bonded to two nitrogen atoms in the nickel complexes of pyridine 2-aldoxime. It would seem likely that the ferrous and ferric complexes of pyridine 2-aldoxime also involve bonding of the metal atom to two nitrogen atoms. This view is supported by the following

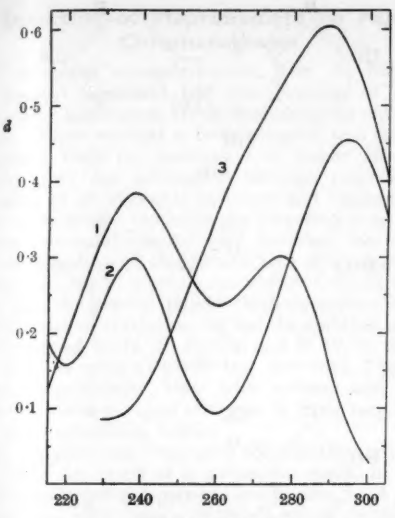

Fig. 2. Absorption spectra of $4 \cdot 0 \times 10^{-5}$ *M* pyridine 2-aldoxime showing three distinct and reversible species: (1) *PAOH* in water, absorption maxima at 238 and 277 mμ; (2) $HPAOH^+$ at *p*H 2, maxima at 238 and 294 mμ; (3) PAO^- at *p*H 12, maximum at 289 mμ. Curves 1 and 2 have isosbestics at 218 and 279 mμ, and relate to the ionization with $pK \simeq 3$. Curves 1 and 3 have an isosbestic at 253 mμ, and relate to the ionization with $pK \simeq 10$

evidence: (1) a number of ferrous complexes with oximes, where bonding to two nitrogen atoms has been established, have similar colours[2,3]; (2) structures of the iron(II)-pyridine 2-aldoxime complex made with Courtauld atomic models show that there is considerably less strain in the molecule when the iron is bonded to the *syn* form; (3) the infra-red spectrum of pyridine 2-aldoxime in chloroform shows a sharp band at $2 \cdot 77\mu$ which is characteristic of a free OH group; this favours the *syn* configuration rather than the *anti*, since in the latter structure the OH would most probably be involved in intramolecular hydrogen bonding with the pyridine nitrogen atom.

Pyridine 2-aldoxime shows two series of reversible spectral changes (Fig. 2) corresponding to two acid ionizations, one with $pK \simeq 3 \cdot 2$ at 25°, which is probably associated with the pyridine nitrogen, and the other with $pK \simeq 10 \cdot 2$, which is probably the ionization of the oxime OH. The normal acid *pK* value for pyridine nitrogen is 5·3, shifting to 5·8–6·0 in some pyridine-2-derivatives[4]; and for oxime OH the *pK* is[5] 12·5–13·0; in the present case conjugation could account for the increased acid strength of both groups.

Using the method of continuous variation, the composition of the ferrous complex was found to be 3 moles of ligand to 1 mole ferrous ion. This result was confirmed by measurements of changes of hydrogen ion concentrations accompanying the formation of the complex at different *p*H values, as well as by the constancy of the equilibrium constant for the formation of the complex calculated on this basis. At 25° these values are of the order of 10^{14} at *p*H 6, 10^{11} at *p*H 5, and 10^{8} at *p*H 4.

In order to account for the reversible colour changes, as well as the marked changes in the observed equilibrium constant with *p*H, we propose the following set of equilibria:

$$Fe^{2+} + 3\,PAOH \rightleftharpoons Fe(PAOH)_3^{2+} \qquad (K)$$

$$Fe(PAOH)_3^{2+} \rightleftharpoons Fe(PAO)_3H_2^{+} + H^{+} \qquad (K_1)$$

$$Fe(PAO)_3H_2^{+} \rightleftharpoons Fe(PAO)_3H^{0} + H^{+} \qquad (K_2)$$

$$Fe(PAO)_3H^{0} \rightleftharpoons Fe(PAO)_3^{-1} + H^{+} \qquad (K_3)$$

A preliminary spectrophotometric study of these equilibria indicated that $pK_3 \simeq 7 \cdot 0$ and $pK_2 \simeq 3$. It was not possible to determine pK_1 since the complex dissociates in more acidic solutions. However, the charges on these ions were substantiated by their behaviour on paper electrophoresis, and by measurements of changes of hydrogen ion concentration accompanying the formation reaction (in unbuffered solutions).

The corresponding ferric complex of pyridine 2-aldoxime is reddish-brown over a wide *p*H range. Only one reversible colour change, to orange, could be observed, corresponding to $pK \simeq 2$. This most probably corresponds to pK_3 of the ferrous complex, the other ionizations being those of strong conjugate acids. The shift in pK_3 from the ferrous to the ferric complex is of the same order of magnitude as that observed for the first ionization of hydrated ferrous and ferirc ions[6,7]. On the other hand, the shift of *pK* for the OH group in free pyridine 2-aldoxime and its ferrous complex, respectively, is unexpectedly large, considering that the types of charge are the same in both the ionization of the free ligand and the third ionization of the ferrous complex. The shift, which is clearly the result of co-ordination of the ligand to the metal atom, shows the extent to which co-ordination can influence adjacent ionizable groups. In this case, the interaction between the metal and the ionizing group is substantially increased through conjugation of the type shown in Fig. 3; in other cases, different types of interaction would be expected to produce different shifts in *pK* values.

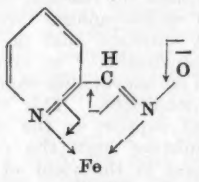

Fig. 3

These results may well be of significance in the interpretation of data obtained for all systems where there are linked effects between the metal ion and the ionizing side-groups of the ligand, such as occurs in hæmoproteins. Studies of this nature help in placing limits on the magnitudes of *pK* changes for ionizing groups which might be expected on account of the difference between their structural environment in the free ligand—where there are no linked effects—and in co-ordination complexes, where specific interaction with the metal ion can occur.

A more detailed study of the kinetics and thermodynamics of this system is being carried out. It is also hoped to extend this work to include systems incorporating other ionizable side-groups as well as other types of interaction.

We wish to thank Profs. A. Day and P. George for their co-operation. This work has been carried out as part of a programme supported by grants from the United States Public Health Service

(*RG* 4850) and the National Science Foundation (*G* 2309).

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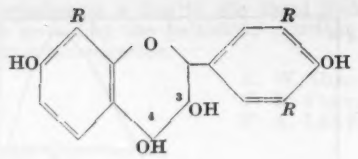
Mechanism of Formation of Anthocyanidins from Leucoanthocyani(di)ns

Based mainly on suggestions made earlier by Robinson and Robinson[1] for their hypothetical *leuco*anthocyanin (flavan-2.3.4-triol), the conversion of flavan-3.4-diols (I) into anthocyanidins by similar mechanism has been discussed by Bate-Smith[2], Bauer, Birch and Hillis[3] and by King and Clark-Lewis[4]. The reaction, induced by hydrochloric acid, was regarded as a dehydration of the 3.4-diol group on the heterocyclic ring (loss of hydroxyl at 4 and hydrogen at 3), followed by oxidation[2–4] or by disproportionation[3,4].

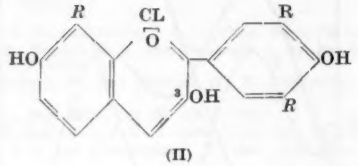
Hitherto *leuco*anthocyanins of unknown structure and also flavan-3.4-diols were conveniently treated with aqueous 2 *N* hydrochloric acid[5], with aqueous 3 *N* hydrochloric acid/propan-2-ol (1 : 5) under pressure[6] or with hydrochloric acid butan-1-ol[4,7] mixtures at 100° C. In most cases the reaction was characterized by low yields of anthocyanidins formed. Logically, if it is correctly surmised that the initial reaction constitutes a dehydration[1–4] at the diol grouping, the formation of anthocyanidins should be promoted by anhydrous conditions. This theory has now apparently found support in the observation that exclusion of moisture from the reaction mixture effects an increase in the yield of anthocyanidins formed.

For example, 7.3′.4′.5′-tetrahydroxyflavan-3.4-diol[8] is converted into anthocyanidins in approximately 37–42 per cent yield by using anyhdrous *N*/30 — *N*/50 hydrochloric acid in propan-2-ol in an enclosed tube under pressure. By comparison, this flavan-3.4-diol (*leuco*robinetinidin) is converted into robinetinidin only, in 3 per cent yield in 3 *N* hydrochloric acid and 20 per cent yield[6] with 3 *N* hydrochloric acid/propan-2-ol under the conditions of Pigman *et al.*[6] Under anhydrous conditions the reaction is also far more rapid, and maximum yields of anthocyanidins result in 15–20 min. compared with 40 min. under previous conditions[6]. Other flavan-3.4-diols of type I behave similarly.

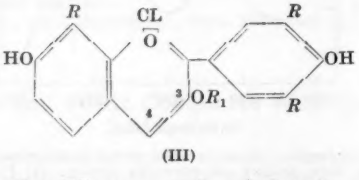
Under the new anhydrous conditions two anthocyanidins of similar coloration but with different rates of migration on paper chromatograms are generated from each flavan-3.4-diol. In all instances examined the anthocyanidin of lower R_F corresponds to that (II) generated under aqueous conditions, and the anthocyanidin of higher R_F is probably the



(I)



(II)



(III)

R = H or OH R_1 = *iso*Propyl

corresponding 3-*iso*propyl ether derivative III (or possibly a 4-*iso*propyl ether of a new type of anthocyanidin). Ether formation with the 3 (or possibly the 4) position of the flavan-3.4-diol occurs prior to conversion into the corresponding anthocyanidin, and is promoted by anhydrous conditions established for the reaction. In the presence of 20 per cent moisture[6] the formation of the ether (III) is almost, but not entirely, inhibited, and mainly one anthocyanidin (II) results.

Pigman *et al.*[6] in 1953 first demonstrated the presence of *leuco*anthocyanins in some commercial tanning extracts, for example, wattle (*Acacia mollissima*), quebracho (*Schinopsis* spp.) and mangrove (*Rhizophora* spp.), and the new method represents a modification of their improved conditions. The tannins present in these extracts may be converted into anthocyanidins in 5–9 per cent, 13–21 per cent (*S. quebracho-colorado*) and 16·5 per cent (*R. mucronata*) yields respectively (cf. ref. 7). Details of a study of the reaction conditions, the reaction mechanism, and implications for the chemistry of condensed tannins will be published elsewhere.

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Detection of Meprobamate on Paper Chromatograms

In a recent communication, Drs. A. Fiori and M. Marigo[1] described the identification of meprobamate by adsorption chromatography on chromatoplates. Their method is both complex and laborious compared with the technique of paper chromatography, but was advocated because meprobamate appeared to be insoluble in water and because there were no available methods for detecting it on paper.

Paper chromatography can, however, be used in the identification of this substance. Meprobamate is slightly soluble in water, and we have found that it may be detected on paper chromatograms by the hypochlorite modification[2] of the chlorination method first described by H. N. Rydon and P. W. G. Smith[3]. The paper is sprayed when dry, first with 1 per cent sodium hypochlorite, then with ethanol and finally with a mixture of equal volumes of 1 per cent starch and $M/20$ potassium iodide.

This method has been used for identifying meprobamate in the urine of a patient in coma, in whom the diagnosis had previously been in doubt. A report of this case, with details of the chemical methods by which the diagnosis was established, is being published elsewhere[4]. In this context, it is of interest that the chlorination method, which has numerous applications, has recently been used to detect barbiturates on paper chromatograms[5].

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BIOCHEMISTRY and PHYSIOLOGY

Cellulose Acetate Membranes suitable for Osmotic Measurements

In a recent paper[1] it has been shown that 'Ultrafein filters allerfeinst', which the manufacturers state are composed of an unnamed cellulose ester, can be used to measure quite low number average molecular weights ($\overline{M}_n$). We have now found that membranes having similar osmotic properties can, in fact, be prepared from cellulose acetate.

The membranes are prepared by casting acetone solutions of cellulose acetate, containing *n*-amyl alcohol as precipitant[2], and allowing them to evaporate until nearly dry. The actual conditions for carrying out this operation appear to be rather critical, and so far a procedure giving absolutely reproducible membranes has not been evolved. However, by using the following method, membranes which show similar variations in osmotic properties to those found with the 'Ultrafein filters allerfeinst' can be prepared.

The following solution is made up: 5 per cent (w/w) cellulose acetate; 5 per cent (w/w) *n*-amyl alcohol; 90 per cent (w/w) acetone, and a volume containing enough cellulose acetate to give a 'membrane density' (that is, weight per unit area) of 0·005 gm./cm.^{2} is poured into a level glass dish and allowed to evaporate at room temperature in a cabinet free from draughts. As the membrane dries out, the surface first of all looks like orange peel and then goes opaque. For osmotic purposes the structure is fixed just before the membrane becomes opaque by pouring on ethanol. In a typical membrane, when the ethanol is poured on, three distinct zones appear: (1) a clear zone; (2) a white zone; (3) a white zone with dark spots. The effective part of the membrane is the white portion, since the clear areas (opaque before the addition of ethanol) have dried out too much and are usually impermeable, while the dark spots indicate pinholes which occur when the membrane has not dried out enough. The membranes are left in ethanol for at least 1 hr. to remove any residual amyl alcohol and are then conditioned to the required solvent; for example, in the case of benzene the membranes are left for periods of at least 1 hr. in (*a*) a 50 ethanol/50 benzene mixture and then (*b*) benzene.

The membranes used in the experiments described here were assembled in standard Zimm-Myerson type osmometers[1] and characterized by: (*a*) the solvent permeability, as measured by the rate of fall of solvent in the measuring capillary from a 10-cm. head; and (*b*) the solute selectivity as measured by the maximum osmotic pressures developed with a 1 per cent (w/w) solution of a 'commercial' polystyrene and/or a 0·025 per cent (w/v) solution of sucrose octaacetate (molecular weight 679).

In Table 1 results with typical and very selective membranes of both cellulose acetate and 'Ultrafein filters allerfeinst' are shown. It will be seen that the cellulose acetate membranes compare very favourably with the 'Ultrafein filters allerfeinst', having similar solute selectivities combined with slightly

Table 1. Comparison of 'Ultrafein Filters Allerfeinst' and Cellulose Acetate Membranes; Benzene Solutions at 30° C.

Membrane		Permeability	Selectivity							
			1·0 per cent (w/w) commercial P.S.				0·025 per cent (w/v) sucrose octaacetate*			
			Rising		Falling		Rising		Falling	
Type	Reference No.	Fall from 10-cm. head of benzene (cm./5 min.)	h_r (cm.)	Time (hr.)	h_f (cm.)	Time (hr.)	h_r (cm.)	Time (hr.)	h_f (cm.)	Time (hr.)
Typical membranes										
'Ultrafein filter allerfeinst'	*UFF/AF* 257/2	0·22	8·95	23	8·81	46	0·34	47	—	—
Cellulose acetate	*CA*2/58	0·81	8·61	16·5	8·65	4	—	—	—	—
Very selective membranes										
'Ultrafein filter allerfeinst'	*UFF/AF* 1257/2	0·062	—	—	—	—	5·30	48·5	5·23	30
Cellulose acetate	*CA*1/68	0·175	11·15	43	—	—	5·11	30	5·44	65

* $h_{theor.} = 10{\cdot}86$ cm.

Table 2. Determination of $\overline{M}n$ of an Ionic Polystyrene using Cellulose Acetate Membranes *CA*3/4; Benzene Solutions at 30° C.

Concentration C per cent (w/v)	Equilibrium osmotic pressures: Rising h_r (cm.)	Rising Time (hr.)	Falling h_f (cm.)	Falling Time (hr.)	$\bar{h}$ (cm.)	Number average molecular weight $\overline{M}_n$
0·100	7·64	40	7·54	31	7·64	3,800±200
0·080	6·15	50	6·33	112·5	6·24	
0·060	4·56	49	4·59	28	4·57	
0·040	3·39	89	3·36	44·5	3·38	
0·020	1·60	70	1·54	50	1·60	

higher solvent permeabilities. The very selective membranes can be used for determining quite low molecular weights and in Table 2 are shown the results obtained using membrane *CA*3/4 with an ionic polystyrene having $\overline{M}_n$ = 3,800. Unfortunately, while it is comparatively easy to make membranes such as *CA*2/58, only a few membranes like *CA*1/68 and *CA*3/4 have so far been prepared. In these experiments benzene was used as solvent, but successful osmotic measurements have also been made in toluene and water.

The cellulose acetate used in the experiments was obtained from the British Drug Houses, Ltd.

I wish to thank Miss S. A. Monksfield and Miss H. M. Sankey for assistance with the experimental work. This work forms part of the research programme of the National Chemical Laboratory and is published by permission of the Director.

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Liquid/Solid Content of Fats

The consistency of margarine and other commercial fats depends to a large extent on the relative amounts of liquid and solid fats present. The usual method for determining these values is by dilatation measurements and the dilatometer is used fairly considerably for this work. There are, however, certain inherent errors in this type of measurement. It is stated that the calculation of liquid/solid content from dilatometric data is either not possible with any degree of accuracy[1] or even that it is impossible[2] with complex mixtures of glycerides. This arises from the fact that a prior knowledge of the glycerides present is required and that mathematical adjustment is needed to take account of the different melting dilatations. Such prior knowledge is not always available.

We have recently found that the use of low-resolution nuclear magnetic resonance spectroscopy provides a new means for such determinations which eliminates many of the inherent errors of the dilatation method. In effect, use is made of the inherent disparity in the nuclear magnetic line-widths observed with liquids and solids. It is known that the shape of the hydrogen resonance line is influenced by the chemical and physical state of the sample and that the width is related to the mobility of the compound containing the hydrogen and to the field homogeneity. With solids the line-width is of the order of several gauss, while with liquids the line-width is very narrow and is determined by the inhomogeneity of the applied magnetic field[3].

An example of the method adopted is illustrated by the determination of the liquid content of simple mixtures of known amounts of tristearin and triolein (tristearin does not form a solid solution in the triolein phase). A bridged-T nuclear magnetic resonance spectrometer was used[4]. The magnetic field was modulated at a sinusoidal frequency of about 40 c./s. with a magnitude of about 30 milligauss, peak to peak. The line-width was determined by the inhomogeneity of the magnetic field and was about 100 milligauss at half-height. Under these conditions the derivative curve shows no signal due to the broad band of the solid, and a measure of the peak-to-peak height of the recorded derivative curve is a direct measure of the amount of liquid present. By comparing the peak-height for any of the mixtures with that for 100 per cent liquid, the liquid content can therefore be determined. Typical results are shown in Table 1. Similar work has also been carried out with other fat mixtures.

Table 1

Known percentage of liquid glyceride	Average percentage found
75·1	74·0
50·2	51·2
25·1	25·4

The new technique has the following advantages:

(*a*) Fats or mixtures may be examined in the state in which they are received, that is, without altering the structure by melting or crystallization.

(*b*) The results are independent of the particular composition of the fat, that is, no prior knowledge of the glycerides present is required.

(*c*) The results are independent of the polymorphic form of the solid present.

A full account of this work will be reported elsewhere.

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Determination of Galactosediethylmercaptal and 3,6 Anhydrogalactosediethylmercaptal with the Anthrone and Seliwanoff Reagents

Some pure 3,6 anhydro-L-galactose was required as standard to determine the concentration of this sugar in several algal polysaccharides. Efforts to prepare it in a crystalline form were unsuccessful. Therefore the standard solution was made up from the 3,6 anhydro-L-galactosediethylmercaptal. Unfortunately the ethylmercaptan liberated on acid hydrolysis of the mercaptal interfered with colour formation in the anthrone and Seliwanoff tests. A similar interference was obtained with the diphenylamine reagent[1]. A method was developed to obtain

from 3,6 anhydro-L-galactosediethylmercaptal, in quantitative yield, a solution of 3,6 anhydro-L-galactose free of ethylmercaptan. The object of this communication is to describe the method whereby sugar mercaptals can be analysed with colorimetric sugar reagents.

The galactose diethylmercaptal was prepared by Wolfrom's method[3] and 3,6 anhydro-L-galactosediethylmercaptal was obtained from the mercaptolysis of agar[3]. Anthrone reagent was dissolved in 80 per cent v/v sulphuric acid. 2 ml. of sugar were added to 10 ml. of anthrone reagent, mixed in an ice-bath and heated for 20 min. at 80° C. The conditions were optimum for the simultaneous determination of galactose and 3,6 anhydro-L-galactose in agar[4]. The conditions for the Seliwanoff test were those of Roe[5].

Solutions of galactose diethylmercaptal (159 μgm./2 ml. water) and 3,6 anhydro-L-galactosediethylmercaptal (82·7 μgm./2 ml. water) were analysed with anthrone and Seliwanoff reagents. The optical densities with the anthrone reagent of the two mercaptals were, respectively, 10 per cent and 98 per cent less than those of equimolar quantities of galactose and 3,6 anhydro-L-galactose (Table 1). With the Seliwanoff reagent the optical density of 3,6 anhydro-L-galactosediethylmercaptal was 6 per cent less than that of 3,6 anhydro-L-galactose.

Table 1. Optical Densities of Mercaptals and Sugar Residues

Sugar	Concentration (μgm.)	Anthrone reagent 625 mμ	Seliwanoff reagent 520 mμ
Galactose	100	0·400	0·015
Galactose from galactose diethylmercaptal*	100	0·395	—
Galactose diethylmercaptal	159	0·360	—
3,6 Anhydro-L-galactose from 3,6 anhydro-L-galactose-diethylmercaptal	50	0·410	0·425
3,6 Anhydro-L-galactose diethylmercaptal	82·7	0·010	0·400

* μgm. of sugar obtained in demercaptolysis with 10 moles mercuric chloride at 50° C. for 1 hr.

In the colorimetric tests the hydrolysis of the mercaptals in hot acids involves removal of the ethylmercaptan and formation of the colour complex with the decomposition products of the sugar residues. The results showed that the formation of colour in the anthrone reaction was inhibited by traces of ethylmercaptan. Therefore the optical density obtained with the anthrone reagent was used as an index to determine the rate and degree of demercaptolysis.

The following method was used for the demercaptolysis of the sugar mercaptals. 5 ml. of a stock solution which contained 794·5 μgm. of galactose diethylmercaptal per ml. or 413·5 μgm. of 3,6 anhydro-L-galactosediethylmercaptal per ml., a microspatula scoop of cadmium carbonate and 10 moles of mercuric chloride/mole of sugar were added to a 50-ml. volumetric flask. The mixture was heated for ½ hr. at 50° C., diluted to volume and then passed through a sintered glass filter to remove the mercury mercaptide.

The conditions reported in the literature for the demercaptolysis of 3,6 anhydro-L-galactosediethylmercaptal require 1·75 moles of mercuric chloride/mole of sugar, heated for 5 hr. at 50° C., yield not reported[6], and 2 moles of mercuric chloride/mole of sugar held for 3 hr. at room temperature with a 56 per cent yield[3]. The results in Tables 2 and 3 showed that at least 4 moles of mercuric chloride were required to obtain complete removal of the ethyl mercaptan. When galactose diethylmercaptal and 3,6 anhydro-L-galactosediethylmercaptal were treated with 10 moles mercuric chloride for ½ hr. at 50° C. a quantitative yield of galactose and maximum colour formation with 3,6 anhydro-L-galactose was obtained. A large excess of mercuric chloride, 100 moles, had no effect on the optical density of solutions of galactose, fructose and 3,6 anhydro-L-galactose with the anthrone and Seliwanoff reagents.

Table 2. Effect of Mercuric Chloride on the Demercaptolysis of 3,6 Anhydro-L-galactosediethylmercaptal*

Mercuric chloride (moles)	2	3	4	10	100
D. anthrone reagent	0·362	0·390	0·405	0·408	0·405

* Reaction for 1 hr. at 50° C. 50 μgm. of 3,6 anhydro-L-galactose.

Table 3. Rate of Demercaptolysis of 3,6 Anhydro-L-galactosediethylmercaptal*

Time in hr. at 50° C.	¼	1	12	30 min. at 25° C.
D. anthrone reagent	0·405	0·408	0·410	0·350

* Reaction 10 moles of mercuric chloride/mole of sugar 50 μgm. of 3,6 anhydro-L-galactose.

In summary, a method has been developed to use colorimetric sugar reagents for the analysis of mercaptals. The sensitivity of the anthrone reaction to ethylmercaptan provided a simple index to determine conditions for complete demercaptolysis of sugar mercaptals.

I wish to acknowledge the assistance of the late Dr. A. N. O'Neill in the preparation of the mercaptals.

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Oxidative Phosphorylation in the Chick Embryo

Synthesis of high-energy phosphate bonds was measured by the estimation of phosphorus : oxygen ratios. The materials used were 7–9 day old chick embryos of a hybrid White Leghorn ♀ × New Hampshire Red ♂. Except for the step *iso*citrate → succinate, the estimations were done on the mitochondrial fraction, prepared according to the method of Hogeboom and Schneider[1]. Oxygen consumption was measured by the Warburg technique, using 0·1 *M* phosphate buffer at *p*H 7·4 with the addition of adequate co-factors and substrates[2]. Phosphorus estimations were carried out according to the method of Lowry and Lopez[3].

Table 1 summarizes our results. Steps, pyruvate → acetyl coenzyme A, and malate → oxalacetate show 3·0 as probable ratios in the cell, whereas phosphorus : oxygen ratios of 2·0 are characteristic of the remaining steps. Estimations of the step *iso*citrate → succinate on mitochondria showed a very low ratio, in the majority of cases less than 1·0; the same occurred when citrate was used as substrate. On the other

Table 1. Phosphorus : Oxygen Ratios of Different Steps within the Krebs Cycle

(In parenthesis : number of experiments)

	Phosphorus : Oxygen ratio	
	Observed	Probable in intact cell
Pyruvate → Acetyl coenzyme A	2·1 (15)	3·0
*iso*Citrate → Succinate	2·0 (16)*	3·0
Alpha-ketoglutarate → Succinate	1·9 (19)	2·0
Succinate → Fumarate	1·8 (16)	2·0
Malate → Oxalacetate	2·6 (13)	3·0

* Obtained on homogenates

hand, when homogenates were used, the phosphorus : oxygen ratio increased to 2·0 with *iso*citrate (14 experiments) and 2·2 with citrate (10 experiments), which point to a probable phosphorus : oxygen ratio of 3·0 inside the cell. In this respect the embryonic mitochondria behave differently from those of the rat liver ; Copenhaver and Lardy[4] showed an estimated phosphorus : oxygen ratio 2·6 for citrate. Our estimations on the rat liver mitochondria gave an average of 2·1 with citrate as substrate.

Full details of this work will be published elsewhere. It was aided by U.S. Public Health Service Grant *C*–2296 (*C*7).

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Synthesis of Amylose by Potato *D*-Enzyme

The synthesis of the chain-forming α-1 : 4-bonds of potato starch (amylose + amylopectin) has for long been ascribed to phosphorylase acting on glucose-1-phosphate and a preformed starch-like primer[1]. We now report the synthesis of amylose-like material by another enzyme system from potato. This synthesis makes use of *D*-enzyme, discovered in 1953 by Peat and co-workers[2]. *D*-enzyme catalyses the reversible disproportionation of maltodextrins, the glucose oligosaccharides containing the α-1 : 4-linkage. For example, maltotriose is acted on to give, as the first products of reaction, glucose and maltopentaose, and at equilibrium glucose and a whole series of maltodextrins are present. However, with maltotriose as the initial substrate, none of the synthetic oligosaccharides is of sufficient length to form a coloured complex with iodine. The minimum length for colour formation is at least 12 glucose units[3]. Incubation of *D*-enzyme with a maltodextrin and glucose lowers the average length of the polymer because of transfer of some of its glucose residues to the added glucose. It was realized that a reversal of this procedure, the removal of glucose, should increase the length of the polymers and might ultimately result in the synthesis from a small maltodextrin molecule of an iodine-staining, amylose-like polysaccharide. If, in addition to *D*-enzyme, the potato is equipped with such a glucose-removing enzyme system, then it is presumably capable of synthesizing amylose by a route other than that provided by phosphorylase. A suitable glucose-removing system is hexokinase and adenosine triphosphate, and hexokinase is known to be in the potato[4]. This will convert glucose into glucose-6-phosphate, and *D*-enzyme does not transfer chain segments from maltodextrins to the sugar phosphate as it does to glucose[5]. The system (maltodextrin + *D*-enzyme + hexokinase + adenosine triphosphate) should therefore bring about amylose synthesis. This has been achieved.

We have preferred to use yeast hexokinase in the present experiments because it can be obtained in a better state of purity than the potato enzyme. In the first instance *D*-enzyme was incubated with a mixture of maltodextrins (malto-pentaose, -hexaose and -heptaose) from which some of the products of *D*-enzyme action alone are long enough to stain with iodine[2]. The same system with added hexokinase and adenosine triphosphate produced iodine-staining material at more than twice the rate. The experiment was repeated with maltotetraose, which with *D*-enzyme alone does not give iodine-staining products. Fig. 1 depicts the course of reaction of *D*-enzyme + maltotetraose in the presence and absence of the glucose-phosphorylating system. When glucose was continuously removed as the 6-phosphate there was an abundant production of iodine-staining polysaccharide, and correspondingly adenosine triphosphate disappeared.

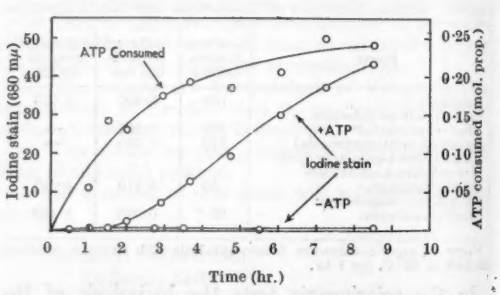

Fig. 1. Synthesis of amylase from maltotetraose. *D*-enzyme was incubated at 25° C. with hexokinase and maltotetraose in the presence and absence of adenosine triphosphate (ATP). The *p*H was maintained at 7·2 by the frequent addition of sodium hydroxide

The suggestion has been made[6] that the potato may use both phosphorylase and *D*-enzyme to synthesize amylose, the product from phosphorylase remaining as amylose and from *D*-enzyme being converted into amylopectin by *Q*-enzyme. Experiments are now in progress to demonstrate the working of such a system *in vitro*.

This work was made possible by grants from the Agricultural Research Council, to which we express our thanks. We also thank Dr. K. Rees for a gift of hexokinase.

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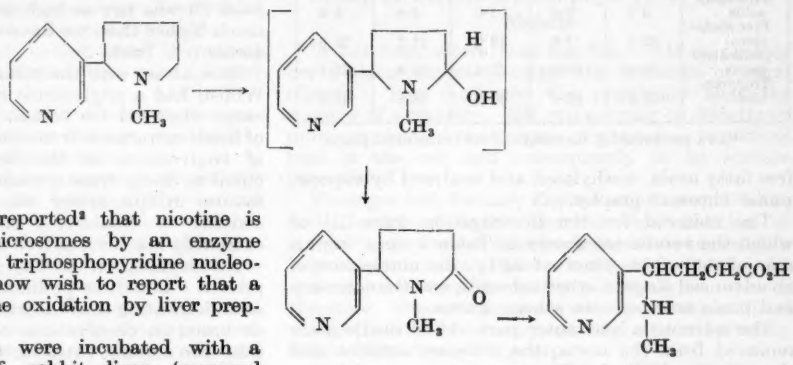
Cotinine: an Oxidation Product of Nicotine formed by Rabbit Liver

A MAJOR advance in the elucidation of nicotine metabolism was the demonstration by McKennis *et al.*[1] that dogs receiving nicotine excreted small amounts of γ-(3-pyridyl)-γ-methylaminobutyric acid and its lactam, cotinine. These workers favoured the view that cotinine was formed in urine by spontaneous lactamization of the acid. However, they also suggested that cotinine might be an intermediate in nicotine metabolism which was hydrolysed to the acid *in vivo*.



We have previously reported[2] that nicotine is metabolized in liver microsomes by an enzyme system requiring reduced triphosphopyridine nucleotide and oxygen. We now wish to report that a major product of nicotine oxidation by liver preparations is cotinine.

3 μmoles of nicotine were incubated with a supernatant fraction of rabbit liver (prepared at 9,000*g*), supplemented with triphosphopyridine nucleotide (0·5 μmole), glucose-6-phosphate (25 μmoles) and nicotinamide (0·1 μmole), for 90 min. at 37° C. under oxygen. Unchanged nicotine was extracted into heptane and assayed spectrophotometrically (259 mμ in 0·1 *N* hydrochloric acid). Cotinine remaining in the aqueous phase was then extracted into chloroform. After washing with 0·1 *M* citrate buffer, *p*H 5·0, to remove an unidentified metabolite, the chloroform phase was extracted with 0·1 *N* hydrochloric acid. Material in the acid phase, accounting for about half the metabolized nicotine, was tentatively identified as cotinine by ultra-violet absorption ($\lambda_{max.}$ 262 mμ), comparative distribution ratios[3] and paper chromatography with three solvent systems.

The metabolite was isolated as follows: nicotine (1,200 μmoles) was incubated with 1,200 ml. of liver supernatant fraction and other components in proportion. Cotinine was extracted into chloroform as described above and the organic phase washed with citrate buffer, *p*H 5·0. After evaporation of the chloroform at room temperature under nitrogen, the residue was subjected to an eight transfer countercurrent distribution between equal volumes of chloroform and 0·6 *M* citrate buffer, *p*H 3·5. Contents of tubes 3–6 containing material of similar partition ratios were pooled, alkalinized and the total basic material extracted into the chloroform phase. The chloroform was evaporated and the residue taken up in ether. After drying the ether phase with sodium sulphate, addition of 60 per cent perchloric acid in ethanol (1 : 1) gave the perchlorate derivative, m.p. 218–219°. The melting point was not depressed on admixture with authentic cotinine perchlorate[4], m.p. 218–219°. Analysis—calculated for $C_{10}H_{13}N_2O_5$: C, 43·41; H, 4·74; found: C, 43·62; H, 5·01. The infra-red spectrum (in potassium bromide pellet) was identical with that of authentic cotinine perchlorate.

When 15 mgm./kgm. of nicotine were administered intramuscularly to rabbits, small amounts of cotinine equivalent to about 10 per cent of the dose were excreted in the urine. Similarly, less than 10 per cent of cotinine administered to rabbits (15 mgm./kgm.) intravenously was found in the urine. Since only small amounts of cotinine are excreted after administering nicotine or cotinine, it is possible that the latter compound is a major metabolite of nicotine *in vivo*.

It seems possible that the first step in the oxidation of nicotine is hydroxylation, followed by oxidation to cotinine and hydrolysis as follows:

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Composition of Lipids isolated from the Aorta, Coronary Arteries and Circulus Willisii of Atherosclerotic Individuals

INVESTIGATIONS of lipid deposits connected with atherosclerosis have usually been concerned with the lipids from the plaques formed in the intima of the aorta[1]. Although the condition of the aorta is a guide to the progress of the disease, dysfunction due to atherosclerosis is most liable to occur in the smaller arteries, especially coronary and cerebral arteries. It has generally been assumed that lipid deposition in these arteries occurs in a similar way to that in the aorta. If this is so, the composition of the lipids deposited should be approximately the same. Lipids extracted from different atheromatous arteries have been examined in order to test this assumption.

The amount of lipid extractable from coronary or brain arteries is extremely small (as indeed it is for healthy aortas), but methods have recently been developed in this laboratory for the separation of as little as 70 mgm. of tissue lipids into phospholipids, sterol esters, triglycerides, free fatty acids and free sterols. The first three groups can then be saponified and the resultant fatty acid mixtures, as well as the

Table 1. Composition of Lipids from Individual Arteries

	Aorta (case *A*)	Circulus Willisii (case *A*)	Coronary arteries (case *A*)	Coronary arteries (case *B*)	Coronary arteries (case *C*)
Yield of lipids*	15·9	10·7	23·7	21·4	15·0
Composition (per cent)					
Phospholipids	26·8	29·5	16·7	16·7	19·2
Free fatty acids	0·9	3·6	1·9	2·8	3·4
Free cholesterol	22·6	7·6	12·2	11·2	21·6
Cholesterol esters	36·4	46·9	21·4	25·9	28·1
Triglycerides	13·9	12·4	49·0	58·6	27·6

* As a percentage of the weight of the freeze-dried tissue.

free fatty acids, methylated and analysed by vapour-phase chromatography.

The material for the investigation (case *A*) of which the results are shown in Table 1 came from a man eighty-eight years of age; the aorta showed an advanced stage of atherosclerosis, and the coronary and brain arteries were atheromatous.

The adventitia and outer part of the media were removed from the aorta, the coronary arteries and the circulus Willisii. The remaining material was cut into small pieces, and the three preparations were freeze-dried before being extracted with methanol–chloroform (1 : 2) at room temperature.

After purification of the lipids by passage of the concentrated methanol–chloroform solution through a column of powdered cellulose[2], the phospholipids were separated from the other lipids by dialysing the latter through a rubber membrane[3], the free fatty acids removed by alkaline extraction and the remaining three groups separated by silicic acid chromatography (essentially according to Borgström[4]). The phospholipids were saponified, first with anhydrous methanolic hydrochloric acid, then with ethanolic potassium hydroxide; the triglycerides and sterol esters were saponified with ethanolic potassium hydroxide alone. The fatty acid fractions and the free fatty acids were converted to their methyl esters and are to be examined by gas chromatography.

The composition of the lipids from the different arteries is shown in Table 1. The amounts of different lipid sub-groups are given as percentages of the total lipid; those for free cholesterol, cholesterol esters and triglycerides were determined colorimetrically. The most striking result is the high percentage of triglycerides in the coronary arteries, compared with the aorta. That this was not an isolated phenomenon characteristic only of case *A* is shown by the last two columns of Table 1, where two further analyses of atherosclerotic coronary arteries (from men of 61 and 66 years, respectively) reveal a high triglyceride content. The triglyceride level of the third example (case *C*) was not as high as the other two, but was much higher than we have ever found in lipids from aortas (cf. Table 2).

Table 2. Comparison of Lipid Composition of Different Arteries

	Aorta stage 0* (2 cases)	Aorta stage I* (5 cases)	Aorta stage II* (6 cases)	Aorta stage III* (5 cases)	Coronaries (3 cases)	Circulus Willisii (1 case)
Yield of lipids†	3·0	4·2	8·5	13·1	20·0	10·7
Composition (per cent):						
Phospholipids	65·8	52·5	33·3	33·6	17·5	29·5
Free fatty acids	5·2	5·8	3·4	1·4	2·7	3·6
Free cholesterol	7·7	11·8	19·1	19·8	15·0	7·6
Cholesterol esters	4·7	14·0	35·1	40·2	25·1	46·9
Triglycerides	15·0	15·4	12·0	8·6	45·1	12·4

* The aortas are classified (ref. 5) according to the appearance of the intima. Stage 0, aorta apparently free from disease; stage I, fatty streaks or spots, distinct plaques of not more than 2 mm. in diameter; stage II, plaques more than 2 mm. in diameter; stage III, complicated lesions (ulcera).
† As a percentage of the weight of freeze-dried tissue.

In contrast with the coronary arteries, the circular Willisii had a triglyceride content falling within the range observed for aortas. Both the total amount of lipids extractable from the tissue and the percentage of triglycerides in the lipids were approximately equal to those from a stage II aorta. The unusual feature in this artery was the comparatively high content of cholesterol esters, coupled with the extremely low level of free cholesterol.

No explanation of the differences is offered at present; but these preliminary findings are reported as an indication that theories concerning atherosclerosis based on observations of the aorta may have to take into account extra factors when they are applied to other arteries.

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Determination of Transaminase Activity in Dogs' Serum and Lymph after Hepatic Damage due to Acute Biliary Obstruction

It is known that glutamic-oxaloacetic acid transaminase (GOT) and glutamic-pyruvic acid transaminase (GPT) are increased in sera of patients suffering from certain liver diseases[1]; but there are scarcely any data available about the pathways of these enzymes. We have therefore studied the changes of the concentration of transaminase of hepatic origin at various points of the blood and lymphatic circulation after damage to the liver caused experimentally by biliary obstruction.

The experiments were carried out on dogs under anæsthesia with chloralose (0·1 gm. per kgm. body-weight). We collected simultaneously samples of sera from the femoral artery and hepatic veins on one hand and thoracic duct and hepatic lymph on the other. The concentration of transaminase was determined by Umbreit's method[2]. Damage to the liver was produced by ligating the common bile duct and injecting 100–150 ml. of 5 per cent sodium chloride solution. The concentrations of

Table 1. Normal Values of the Activities of Glutamic-oxaloacetic and Glutamic-pyruvic Acid Transaminases in Dogs

	Art. fem. ser.		V. hep. ser.		D. thor. lymph		Hepatic lymph	
	GOT	GPT	GOT	GPT	GOT	GPT	GOT	GPT
Mean	70	53	78	80	67	52	121	70
Extreme values	23–134	11–89	20–124	20–195	7–126	8–119	80–136	38–125
Number of cases	19	18	18	15	20	19	5	4

glutamic-oxaloacetic acid transaminase and of glutamic-pyruvic acid transaminase were determined 15 min. before and 15 min. after the injection.

Table 1 summarizes the values found in normal controls, and Fig. 1 illustrates the values found after hepatic damage.

Compared with the values of the controls, the concentrations found after hepatic damage are significantly greater in all our experiments.

So far as we know, no data on transaminase activity in the hepatic veins or in the lymph of the various lymphatic ducts have been published. According to our results, the activities of both glutamic-oxaloacetic and glutamic-pyruvic acid transaminase are considerably increased in every fraction of the blood and lymph after hepatic damage; the actual rise is to some extent variable. (In the experiment represented in Fig. 1 the greatest change occurred in the serum from the hepatic vein.)

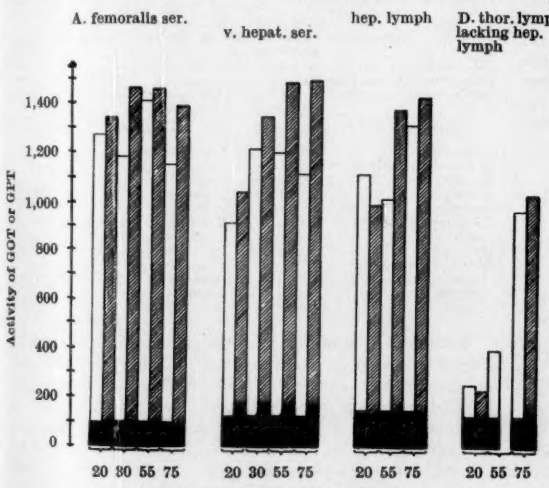

Fig. 1. Activity of glutamic oxaloacetic acid transaminase (white); and of glutamic pyruvic acid transaminase (hatched); mean of control periods (black)

Histological examination of the liver tissue showed intense hyperæmia, œdema and damage to the liver cells (vacuoles, hyalin degeneration).

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Effect of Insulin on Sulphydryl Groups in Muscle

It has been shown that the free —SH content of nerve tissue increases under the influence of stimulation. This suggested the possibility that the number of titratable —SH groups may be directly or indirectly related to the ratio of potassium to sodium ions in the cell and consequently to its surface potential[1,2].

Flückiger and Verzár[3], Zierler[4] and Creese, D'Silva and Northover[5] have observed that addition of insulin *in vitro* to rat-muscle preparations causes gain in potassium ions and loss of sodium ions by the cell and an increase of its resting potential. It seemed, therefore, interesting to investigate whether these changes would be accompanied by a corresponding fall in titratable —SH groups.

Diaphragms were removed from male *CF* Wistar rats (100–145 gm.). Each hemidiaphragm was washed, and suspended in 150 ml. of a glucose–saline medium buffered to *p*H 7·4 and containing 6·15 μmoles potassium ion/ml. To one of the hemidiaphragms was added insulin ('Iletin', Lilly) at a concentration of 0·1 unit/ml.; the other served as a control. A mixture of 95 per cent oxygen and 5 per cent carbon dioxide was bubbling through both preparations for 2 hr. at room temperature.

Content of potassium ions was determined in eight pairs of hemidiaphragms after 2 hr. incubation. The muscle was blotted and submitted to the wet-ashing procedure described by Ballantine and Burford[6]; content of potassium ions was measured by means of a flame photometer using an internal standard. The mean potassium ion content of the insulin-treated hemidiaphragm was 130·4 (±33·5 *S.D.*) μmoles/gm. of wet weight; the control muscles contained 82·3 (±32·8) μmoles/gm. The increase in potassium ion content, 48·1 μmoles, is 58·5 per cent of the controls.

Thirty pairs of hemidiaphragms were used for the determination of —SH groups. The tissue was frozen with dry-ice, ground in a Potter–Elvehjem homogenizer and extracted with the suspension medium. After centrifugation at 4,000 r.p.m. for 20 min., —SH groups were determined in the supernatant by means of the amperometric titration method of Benesch, Lardy and Benesch[7]. In 26 experiments the —SH content of the insulin-treated hemidiaphragm decreased by an average of 22·1 per cent. The control muscle contained 5·32 (±1·08 *S.D.*) μmoles/gm. wet weight; under the influence of insulin the —SH groups fell to 4·14 (±0·84) μmoles. The difference is significant at the level of $P = 0{\cdot}05$–$0{\cdot}02$. In four experiments —SH groups increased by an average of 1·22 μmoles/gm.: it could not be ascertained whether these results were due to a technical failure or to some particular condition of the animals.

In some experiments, the extract was dialysed in a shaking dialyser against 25 vol. of the extraction

medium. As in brain tissue[8], the major proportion (80 per cent) of the —SH groups in muscle was bound to non-dialysable molecules, presumably to proteins. The decrease caused by insulin affected about equally the dialysable and non-dialysable sulphydryl fractions.

The fact that insulin causes hyperpolarization of the cell surface, increase of the ratio of potassium to sodium ions and decrease of —SH groups can be interpreted in various ways. In terms of the membrane theory, it could be assumed that insulin, by its action on metabolic processes, increases the efficiency of the ionic 'pumps' or that it acts directly on the membrane and alters its permeability properties. The latter action is assumed to operate in facilitating the entry of glucose into the cell[8]. There is also some evidence that glycogen fixes potassium ions[9] so that increased glycogen synthesis may result in higher intracellular potassium.

In view of certain observations on protein configuration in resting and stimulated cells, insulin can be assumed to act primarily by modifying the structure of certain protein molecules. Stimulation and subsequent depolarization, with lowered ratio of potassium to sodium ions, are accompanied by an 'unmasking' of titratable —SH groups and other ionized side-groups, suggesting a general 'loosening' of the structure of protein molecules[1,3,10]. In the opposite direction, hyperpolarization, with raised intracellular ratio of potassium to sodium ions could be characterized by a decrease in ionized side-groups and tendency to a more rigid protein configuration. Further investigations are being conducted to determine whether modifications of protein structure represent a determining factor in the mechanism of cellular rest and excitation.

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Reduction of Neotetrazolium Chloride by Vitamin K_3

Menadione (vitamin K_3, 2-methyl-1.4-naphthaquinone) has become increasingly associated with pathways of electron transfer. It has been implicated in the nitrate reductase sequence; in the processes of photosynthetic phosphorylation; in a non-phosphorylative oxidative pathway; in menadione reductase and in the general respiratory chain and associated processes of oxidative phosphorylation (cf. ref. 1). Menadione has recently been associated with an enzyme sequence connecting the oxidation of succinate with the reduction of neotetrazolium chloride[1]. The vitamin K_3 involved in such reactions can be followed by spectrophotometric rate measurements[2].

This communication shows that it is also possible to demonstrate that vitamin K_3 is involved in redox reactions by adding neotetrazolium chloride; reduced menadione reacts directly and non-enzymically with neotetrazolium chloride at *p*H 7·4 and 37° C., yielding the intensely coloured insoluble formazan. As stated by Shelton and Rice[3], the absorption maximum of the formazan varies with the method of reduction: enzymic reduction yields a product with a maximum absorption at 510 mμ; chemical reduction (for example, by reduced menadione or dithionite) yields a product with an absorption maximum at 540 mμ.

In the following experiments the reaction mixture used contained 1 ml. of a phosphate – versene mixture (1·0 ml. phosphate buffer, *p*H 7·4, 0·1 molar: 0·05 ml. sodium versenate, *p*H 7·4, 0·1 molar) and 0·15 ml. of 1 per cent neotetrazolium chloride. Other additions mentioned in Table 1 were made in a volume of 0·1 ml. Incubation was at 37° C. and the formazan was extracted with 4 ml. of ethyl acetate; the extinction was obtained using a Hilger 'Uvispek' spectrophotometer. Vitamin K_3 was added as a suspension in phosphate buffer, bovine plasma albumin and ethanol.

Table 1. Extinction read at 540 mμ in a 'Uvispek' Spectrophotometer

Path-length 1 cm., incubation time 30 min. except for reduced menadione (5 min.), and cysteine + vitamin K_3 (15 min.); reagents and volumes described in the text. All values refer to the addition of 1 μmole of reagent

Addition	Extinction	Addition	Extinction
Menadione	0·007	Ascorbic acid + vitamin K_3	0·225
Reduced menadione	0·237	Glutathione + vitamin K_3	0·003
Ascorbic acid	0·066	Cysteine + vitamin K_3	0·960
Glutathione	0·002	Reduced diphosphopyridine nucleotide + vitamin K_3	0·036
Cysteine	0·009	Vitamin K_1 + ascorbic acid	0·123
2,3 Dimercapto-1-propanol	1·490	Vitamin K_1 + ascorbic acid	0·091
Hydroquinone	0·000		
Reduced diphosphopyridine nucleotide	0·000		
Vitamin K_1	0·015		
Vitamin E	0·006		

Reduced menadione was prepared as described by Fieser[4]; a grey powder was obtained which had absorption maxima at 241 and 330 mμ as mentioned by Colpa-Boonstra and Slater[2]. Direct reduction of neotetrazolium chloride by the following reagents was also tried: reduced diphosphopyridine nucleotide (Boerhinger, 90 per cent pure); glutathione (Distillers Co., Ltd.): ascorbic acid (Roche); cysteine; 2,3 dimercapto-1-propanol (BAL, Boots Pure Drug Co., Ltd.); hydroquinone; vitamin E (L. Light and Co.); vitamin K_1 (Roche).

Other than reduced menadione, only 2,3 dimercapto-1-propanol reacted directly with neotetrazolium chloride to any substantial degree; slight production of formazan was observed with vitamin C (Table 1). Several of the reagents which did not reduce neotetrazolium chloride directly, were found to reduce menadione, which then led to the formation of formazan. For example, cysteine reduced menadione with a consequent formation of formazan on incubation, in spite of the fact that cysteine (and other similar compounds, for example, glutathione) combines readily with menadione under the conditions used to yield 3-substituted naphthaquinones. Under the conditions used (in *p*H 7·4 phosphate buffer: versene) the photochemical reduction of neotetrazolium chloride catalysed by cysteine with either riboflavin or riboflavin phosphate[5] was negligible.

The reduction of vitamin K_3 by vitamin C appears to occur to a considerable extent, indicating that the following reaction is displaced to the right in the presence of neotetrazolium chloride:

ascorbate + menadione → dehydroascorbate + reduced menadione

This reaction between vitamin C and menadione is stimulated by tissue suspensions[1], but whether this stimulation is enzymic in character must await further investigation. The stimulatory power of homogenates is relatively insensitive to boiling. The stimulatory power of both rat liver and rat mammary gland homogenates is largely concentrated in the soluble fraction after removing the mitochondria and microsomes by differential centrifugation in 0·25 molar sucrose.

Reduced diphosphopyridine nucleotide reacted only slightly, if at all, with menadione to yield reduced menadione; reduced diphosphopyridine nucleotide had no direct effect on neotetrazolium chloride, as has been reported by Zöllner and Rothemund[6]. Typical results are shown in Table 1.

It seems possible, therefore, that in certain cases the fact that vitamin K_3 is involved in redox reactions can be demonstrated by the ready interaction of reduced menadione with neotetrazolium chloride.

I am grateful to Dr. A. L. Greenbaum and D. N. Planterose for helpful comments and suggestions; this work was carried out during the tenure of a Beit Memorial Fellowship.

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Effect of β-Hydroxybutyrate Injections on the Pancreatic Activity of Guinea Pigs

β-Hydroxybutyrate has been found to cause hyperglycæmia, glycosuria and lowered glucose tolerance in guinea pigs and rabbits when injected in gradually increasing doses for some time[1,2]. On injection in rabbits, this compound produces an initial state of hypoglycæmia followed in the long run by permanent hyperglycæmia. That this may be due to an initial state of hyper-insulinism, followed by hypo-insulinism due to an overwork atrophy of the *B*-cells, caused by continued stimulation has been suggested[3–6].

Since β-hydroxybutyrate is an important intermediary metabolite, its effect on the normal pancreas is evidently very interesting, and the present series of investigations have therefore been started to elucidate its mechanism of action. The present report indicates the effect produced by continued injections of β-hydroxybutyrate (sodium salt) on the amylolytic and insulin activity of the pancreatic tissue of guinea pigs.

The preliminary experiments reported here were carried out on two groups of guinea pigs. One group was kept as control, and the animals of the other group were given injections of sodium β-hydroxybutyrate (L. Light and Co., Ltd.). The initial dose was 50 mgm. per animal, and this was gradually increased to 100 mgm. per animal. At regular intervals the pancreas was removed from two animals of each group and a portion of pancreatic tissue assayed for amylase activity by Willstätter's method[7]. Another portion of the tissue was extracted for insulin[8] and the extracted insulin assayed on rabbits by the method of Burn[9]. The results are given in Table 1.

Table 1. Average Values of Pancreatic Amylase and Insulin of Guinea Pigs subjected to Injections of β-Hydroxybutyrate (Sodium Salt)

No.	Days of injections	Amylase activity mgm. of maltose/gm. of dry pancreas	Insulin potency (percentage reduction/gm. pancreas)
1	0 (control)	654·1	14·72
2	12	596·7	86·10
3	25	457·2	—
4	36	100·8	30·6

Table 1 reveals that the pancreatic amylase activity decreases with gradual increase in the dosage of β-hydroxybutyrate injections, whereas the insulin potency shows an initial increase and is then followed by a decrease. The decrease in pancreatic amylolytic activity may be due to a possible lowering of the rate in the proteosynthetic activity of the acinar cells as a result of a possible pharmacological response produced by β-hydroxybutyrate, or it might be due to a physiological response of the organ to maintain the overall enzyme–hormone balance or both. The changes in insulin potency as observed are in conformity with the order of earlier observations (*loc. cit.*), namely, initial stimulation of *B*-cells followed by a possible overwork atrophy as a response to β-hydroxybutyrate injections.

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Leucine Aminopeptidase Activity in Mast Cells

During investigations of the behaviour of leucine aminopeptidase activity of blood-serum in patients with dermatoses and tumours[1–3], in a case of diffuse skin mastocytosis of a new-born, we detected heightened activity of leucine aminopeptidase. After mechanical friction of the affected skin, greater activity of leucine aminopeptidase occurred. From this we supposed a release of leucine aminopeptidase from the mast cell infiltrates of the skin. As is well known, in urticaria pigmentosa mechanical irritation of the skin lesions give rise to a degranulation of mast cells[4,5] with liberation of histamine and serotonin. Indeed, there is no doubt that mast cells contain the enzyme leucine aminopeptidase. Using Burstone and Folk's histochemical method[6], we were able to demonstrate a strong positive cytoplasmic

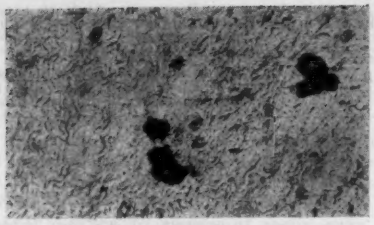

Fig. 1. Positive leucine aminopeptidase reaction in mast cells of rat mesentery

leucine aminopeptidase reaction in the mast cell infiltrates of the cutis in the above-mentioned case. Also in the mesentery of rats, mast cells likewise show a weak positive but distinct cytoplasmic leucine aminopeptidase reaction (Fig. 1), while other connective tissue cells are free of histochemically demonstrable activity of leucine aminopeptidase. To answer the question, whether with degranulation of mast cells there is a release of leucine aminopeptidase in the surrounding tissue, some experiments on rats were performed. Following Fawcett's method[7] for the release of histamine by mast cells, eight black rats (150–200 gm.) were killed and, after being bled, the abdomen was opened, the mesentery detached in its entirety at the root and separated from the intestine. After incubation in 2 ml. aqua bidest. or Tyrode's solution for 20 min. at 20° C. in 0·5 c.c. of the filtrate, the activity of leucine aminopeptidase was determined by a modified method of Green *et al.*[1]. Histological controls showed no greater morphological alterations of the mast cells by treatment with Tyrode's solution; however, after treatment by aqua bidest., the well-known osmotic rupture of the mast cells with degranulation[5,7] resulted (Table 1).

It is significant that activity of leucine aminopeptidase was demonstrable after treatment with Tyrode's solution. It is an open question whether or not this activity is connected with a release by mast cells. However, it should be noted that in a pretreated mesentery (Tyrode's solution or aqua bidest.) histochemically a real positive reaction of leucine aminopeptidase in mast cells could not be found. After osmotic disruption of the mesenteric mast cells by incubation in aqua bidest., the increase of activity of leucine aminopeptidase in the incubation fluid was about 100 per cent. This shows that osmotic rupture of the mast cells is concomitant with a release of leucine aminopeptidase.

It is still not possible to say, however, whether leucine aminopeptidase would be released in the process of physiological degranulation. Only suggestions can be made concerning the significance of leucine aminopeptidase in mast cells. Leucine aminopeptidase itself is probably not a uniform enzyme, but a mixture of di- and poly-peptidases[8]. Some observations[9,10] suggest that proteolytic enzymes, including leucine aminopeptidase, may be of importance in the process of liberation of heparin from native lipoprotein-complex[11,12] and perhaps also from the release of histamine or hydroxytryptamine. Also there may exist a relation to anaphylactic reactions, in which not only morphological changes in mast cells (degranulation) but also a higher activity of proteolytic enzymes can be found[13–15].

Table 1. Leucine Aminopeptidase Activity (in μgm. of Liberated β-Naphthylamine from L-Leucyl-β-Naphthylamide) in 0·5 ml. Fluid after Incubation (20 min. at 20° C.) of 1·0 gm. Rat Mesentery in 2·0 ml. Fluid

Rat	Incubation-fluid	
	Tyrode's solution	Aqua bidest.
1	220	422
2	263	423
3	248	395
4	244	417
5	238	421
6	227	409
7	243	449
8	231	422
	239 ± 13	420 ± 15

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New Inhibitor and Erythrocyte Receptor Substances for Certain Asian Strains of Influenza Virus

Several investigators[1–5] and ourselves[6,7] have shown that individual Asian strains of influenza *A* virus can be divided into two groups on the grounds of their sensitivity to inhibitors of hæmagglutination. The so-called 'non-avid'[5] or *Q*-phase[6] strains are not inhibited by non-immune sera, and only moderately by homologous hyperimmune sera. On the other hand, both non-immune and immune serum inhibitors are highly active against the 'avid' or *R*-phase strains.

In the present work we investigated the factor responsible for the hæmagglutination-inhibiting activity of normal sera against the 'avid' Asian strains. The erythrocyte receptors were also studied. The spiral loop micro-technique described by one of us[8] was used in the hæmagglutination-inhibiting tests. The neutralization tests were performed in chorio-allantoic membrane cultures according to Horváth's method[10]. Fowl erythrocytes were used throughout.

Table 1 shows that none of the six animal species examined had serum inhibitors against the Singapore 1/57 strain, while all but the pooled mouse serum were highly inhibitory against Budapest 23/57, a representative of the 'avid' Asian strains. A sample of each of the sera listed in Table 1 had been boiled and vigorously stirred for 30 min., then centrifuged. The supernatants were tested. The hæmagglutination-inhibiting titres against the 'avid' strains were remarkably enhanced by boiling, while a nearly complete inactivation of the Francis and Chu inhib-

Table 1. COMPARISON OF THE HÆMAGGLUTINATION-INHIBITING TITRES OF NORMAL AND BOILED SERA

Sera	Virus strains							
	PR8		Lee		Sing. 1/57		23/57	
	a	*i*	*a*	*i*	*a*	*i*	*a*	*i*
	Unheated							
Human	32*	128	32	64	—	—	512	128
Rabbit	4	256	64	128	—	—	512	256
Guinea pig	—	128	8	64	—	—	1,024	512
Chicken	—	8	—	32	—	—	64	32
Ferret	—	4	—	16	—	—	256	256
Mouse	—	32	—	256	—	—	64	64
	Boiled for 30 min.							
Human	—	—	—	—	—	—	2,000	512
Rabbit	—	—	—	—	—	—	1,600	512
Guinea pig	—	16	—	16	—	—	6,400	5,000
Chicken	—	—	—	4	—	—	2,000	1,024
Ferret	—	—	—	—	—	—	2,000	1,024
Mouse	—	—	—	—	—	—	256	64

a, Active; *i*, inactivated at 56° C. for 30 min.
* Reciprocals of the hæmagglutination-inhibiting titres.

itors occurred as demonstrated by the disappearance of the hæmagglutination-inhibiting titres against active and heat-inactivated *PR*8 and Lee viruses. Boiled guinea pig sera had particularly high titres. The lowest temperature rendering sera more inhibitory against the 'avid' strains was dependent on the species; for example, heating to 56° C. for 30 min. was sufficient for guinea pig sera to develop higher hæmagglutination-inhibiting titres while sera of other species required considerably higher temperatures to become more effective. The 'non-avid' Singapore strain was not inhibited even by boiled sera.

Heating to 56° C. for 30 min. rendered *PR*8 and Lee virus preparations more sensitive to non-specific serum inhibitors but did not alter, or even lowered, the sensitivity of the 'avid' strains.

We have investigated some properties of the boiled inhibitor. It has been proved to be undialysable and biuret-positive; it is precipitated by 50 per cent acetone or 66 per cent ethanol; the precipitates can be re-dissolved without any loss in their inhibitory activity in saline; the inhibitor is completely precipitated in 0·35 saturated solutions of ammonium sulphate; digestion at 37° C. in a 0·25 per cent trypsin solution for 30 min. destroys its activity. Treatment of sera with crude cholera filtrate inactivated this inhibitor only partially and the Francis-type inhibitor had disappeared completely. Treatment with *M*/200 potassium periodate at room temperature for 3 hr. scarcely diminished the hæmagglutination-inhibiting titres of normal sera to the 'avid' strains, whereas those to the active and heat-inactivated preparations of *PR*8 and Lee viruses disappeared almost entirely. No carbohydrate could be detected in preparations purified by fractional precipitation with ammonium sulphate. The Molisch–Udránszky and the Antron tests were used.

Pre-epidemic human sera, as well as normal guinea pig sera, had also neutralizing titres against the 'avid' strains but not to the 'non-avid' Asian strains. The titres against 100 *ID*50 of an 'avid' strain attained 1 : 32 in pre-epidemic human and exceeded this level in normal guinea pig sera. Preliminary observations appear to suggest a direct relation between the hæmagglutination-inhibiting and neutralizing titres of normal sera. In a single experiment, however, boiling remarkably diminished the neutralizing capacity, in contrast to the simultaneous rise in the hæmagglutination-inhibiting titre.

Our results indicate that the 'avid' Asian strains are inhibited, and, to some extent neutralized, by a normal serum factor which is different from the non-specific inhibitors of hæmagglutination already described. The new inhibitor is supposed to be a thermostable protein or polypeptide.

The existence of a serum inhibitor reacting exclusively with the 'avid' Asian strains made reasonable a search for erythrocyte receptors supposed to be specific for those strains. The possible destruction of the receptors to the 'avid' strains by each of the strains *PR*8, Lee and Singapore 1/57 was examined first. Mixtures of virus and red cells were kept at 37° C. until the cells had become inagglutinable or barely agglutinable by all the strains tested except the 'avid' strains. The agglutinability by the latter was not altered by the above treatment. In further experiments red cells were treated with 'avid' strains in a similar manner. In these instances the rate of elution was slow, as compared with that of the 'non-avid' strains, and the red cells remained agglutinated even after extremely long incubation. We failed thus to obtain cell suspensions suitable for re-agglutination tests.

The effects of receptor-destroying enzyme as well as of potassium periodate on the red cell receptors reacting with the 'avid' strains were also studied. Using each of these treatments appropriately, we succeeded in obtaining cells of unaltered agglutinability by 'avid' strains but entirely inagglutinable by other strains of influenza virus.

Our preliminary results suggest that a receptor substance different from the red cell receptors to other strains of influenza virus is at least one of the substances responsible for the interactions between red cells and 'avid' strains of Asian virus.

We thank Dr. A. Isaacs, National Institute for Medical Research, London, for making available the Singapore 1/57 strain and crude filtrate of *V. cholerae*. A full account of this work will be published in the *Acta Virologica* (Prague).

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Effect of Brain Ganglioside on the Heart of the Clam

A PURIFIED preparation of brain ganglioside, a macromolecular glycolipid the structure of which has been recently considerably clarified[1], has been shown to inhibit in low concentration the viral hæmagglutination reaction[2] and to inhibit in the same concentrations the neurotoxic effect in mouse brain of influenza *PR*8 and *NWS* viruses[3]. The consideration of the possible membrane and transport role that brain ganglioside might have in the central nervous system has led to the investigation

of the effect of this substance upon the heart of *Venus mercenaria* (clam), an organ which had been used in the bioassay of acetyl choline, 5-hydroxytryptamine, and other substances with known or suspected neurohumoral function[4,5].

The clam heart system employed was essentially that described elsewhere[5], with the exception that a 5-ml. bath was used. (We are grateful to Dr. M. K. Paasonen for demonstrating the method which he employs for bioassay with clam heart, and for a sample of 5-hydroxytryptamine creatine sulphate.) The bathing fluid consisted of sea water, with and without added benzoquinonium ('Mytolon'). Most preparations functioned well up to 10 and 15 hr., and stable function was established for at least 1 hr. before test substances were added. All hearts were highly responsive to 5-hydroxytryptamine creatine sulphate in the usual doses[5].

Both brain ganglioside salt and its ash-free derivative were employed[1]. Brain ganglioside salt in concentrations as low as 0·06 μgm./c.c. of suspension fluid produced a definite increase in the amplitude of contraction (12–30 per cent). At doses greater than 0·4 μgm./c.c. an increase in amplitude of contraction was accompanied by an increase in rate as well. At doses between 40 and 200 μgm./c.c. an increase in tonus also occurred, with definite raising of the baseline. At doses between 200 and 400 μgm./c.c. a tetanic state of contraction was observed. All the above effects were readily reversed by washing the heart with sea water. However, there appeared to be a cumulative effect in individual hearts on repeated administration of large doses of brain ganglioside, evidenced by a diminished responsivity to subsequent doses of brain ganglioside, although the heart retained normal responsivity to 5-hydroxytryptamine. Even while the heart was responding to brain ganglioside present in the bathing fluid, the addition of 5-hydroxytryptamine produced a superimposed stimulatory effect.

All these responses were observed whether or not benzoquinonium (6 μgm./c.c.) was present in the fluid. Since equivalent responses were obtained with both brain ganglioside salt, and ash-free brain ganglioside, the stimulatory effect does not appear to be dependent upon either the presence of a free or neutralized carboxyl group in the neuraminic acid of brain ganglioside. Neuraminic acid itself, obtained by hydrolytic cleavage of ash-free brain ganglioside[1], in doses of 60–120 μgm./c.c., produced a small increase in the amplitude of contraction comparable to the response obtained with only 0·06 μgm./c.c. of the intact brain ganglioside.

The active concentrations of brain ganglioside are low. Considering that the functional unit of this macromolecular substance is its structural repeating unit, molecular weight[1] approximately 3,314, then brain ganglioside is active in this system at concentrations of 10^{-8} molar. If, on the other hand, the functional unit is considered to be that indicated by the molecular weight determination of aqueous brain ganglioside (minimal molecular weight 250,000), then brain ganglioside is active at concentrations of 10^{-10} molar.

These findings, which will be described in detail elsewhere, together with the previous observations on the structure of brain ganglioside[1] and on its action in other biological systems[2,3], suggest the possibility that brain ganglioside may play a part in transmission phenomena in the central nervous system.

These studies have been supported in part by grants from the U.S. National Institutes of Health (*M*-2095 and *B*-1616).

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Succinic Dehydrogenase Activity in Brain Tissue of Rats after Ovariectomy and Steroid Administration

Anæsthetic properties of certain steroids have been demonstrated by Selye[1], and Michaelis and Quastel[2] have stated that anæsthetic activity depends on inhibition of the utilization of glucose and oxygen by brain tissue. Later, Gordan and Elliott[3] showed that addition of certain steroids to brain cells *in vitro* produced a prompt inhibition of the rate of uptake of oxygen by these cells. Conversely, in castrated male rats, that is, in animals deficient in gonadal steroids, the uptake of oxygen by the brain increased up to 35 per cent[4,5]—a fact which suggests that the steroids, by virtue of their inhibiting effects, act as brakes on cerebral metabolism. Further experiments indicated that the known anæsthetic potency of the steroids parallels their degree of inhibition[6]. The site of the steroid inhibition has since been found to be at the dehydrogenase-level rather[7,8] than the cytochromes, where other anæsthetic agents exert their effects. Thus, the distinctive effects of steroids on the respiratory metabolism of tissues can be ascertained by means of the quantitative analysis of the dehydrogenase activity under conditions of steroid administration or deficiency.

Scrutiny of the literature revealed that the results obtained on the influence of steroids on the oxygen uptake and respiratory enzyme activity were based upon experiments on male rats exclusively. In our previous experiments the activity of succinic and isocitric dehydrogenases in brain and other tissues under various experimental conditions were determined in male rats also[9].

Therefore, in the present experiments female rats were used and the succinic dehydrogenase activity of brain tissue under the conditions of ovariectomy and administration of gonadal hormones was assayed.

Seventy adult healthy female rats of the random-bred Hebrew University strain were spayed at the age of 2 months and divided into four groups. 15 animals were injected with 1 mgm. testosterone, 15 with 5 μgm. œstradiol-benzoate and 15 with 1 mgm. of progesterone, whereas 25 ovariectomized rats received no injections. An additional group of 24 normal animals served as a standard of comparison. The injections were given for a period of 30 days and were discontinued 24 hr. prior to the examination. The dehydrogenase activity was quantitatively estimated by a modification of the Kun and Abood[10] tetrazolium method, developed in our laboratory[11]. The method is based on the degree

of reduction of tetrazolium to the end-product, formazan, during the enzymic oxidation of succinate to fumarate and is estimated colorimetrically.

The modification is as follows. The incubation mixture contains 0·5 ml. of a 10 per cent tissue homogenate in potassium phosphate buffer, 0·25 ml. of a 0·08 *M* solution of sodium succinate substrate and 0·25 ml. of a 0·1 per cent solution of neotetrazolium chloride, at 37° C. for 20 min. By the addition of 2 ml. of a mixture of equal parts of ethyl acetate–ethanol, the reaction is stopped and the coloured end-product, formazan, is extracted. Thus the colour of the formazan solution is rendered stable for a relatively long period, and the reaction is suitable for estimating small quantities of enzymes—the modified procedure eliminating thereby the main drawbacks of the original method.

It can be seen from Table 1 that after ovariectomy the succinic dehydrogenase activity in brain tissue increased markedly. The different gonadal hormones administered exerted a distinctive influence on the succinic dehydrogenase activity of the brain in ovariectomized rats. All three steroids inhibited in a statistically significant degree (after ovariectomy) the elevated enzyme activity. Testosterone decreased this activity to the greatest extent, depressing it relatively far beneath the normal level; œstradiol effected a marked decrease from the normal degree, whereas progesterone, although exerting an inhibiting effect, levelled the enzyme activity to the normal values only.

Table 1. Effects of Ovariectomized and Gonadal Steroids on Cerebral Succinic Dehydrogenase Activity

The figures express the amount of formazan (μgm.) produced by the enzyme during 20 min. of incubation at 37° C. in 1 ml. of 10 per cent tissue homogenate

Treatment	No. of animals	Age in months	Mean ± S.E.	Alteration (per cent)	t	P
Intact, female	24	3	526±18	—	—	—
Ovariectomized	25	3	623±27	+18·4	3·03	0·001
Ovariectomized+testosterone	15	3	329±48	−37·4	3·78	0·001
Ovariectomized+œstrogen	15	3	472±11	−10·2	2·57	0·02
Ovariectomized+progesterone	15	3	526±25	0	2·62*	0·02*
Intact, male	10	3	434±26	—	—	—

* These figures were calculated in relation to those of the ovariectomized, all the rest to the intact, animal.

In comparison with normal male rats of corresponding age the values for activity of succinic dehydrogenase in brain tissue of the intact female are somewhat higher. However, the increase of activity of succinic dehydrogenase after ovariectomy is similar to that observed in male rats after castration; the action of œstrogen as inhibiting the enzyme activity also corresponds to its effects in male. Contrary to these, the effect of testosterone is inhibitory in the female, while in the male this hormone increased still further the enzyme activity already elevated after castration[9].

Since corresponding effects of progesterone and testosterone in many instances, including anæsthetic actions, are known, the results obtained with progesterone administration were rather unexpected. In the present experiments this hormone was the least effective in decreasing the enzyme activity, in contrast to testosterone, which inhibited it to the greatest extent.

A full account of the experiments will be published elsewhere.

We are indebted to Mrs. J. Kidron for technical help.

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BIOLOGY

'Pheromones': a New Term for a Class of Biologically Active Substances

During the past few decades, investigations have been made into various active substances which, though they resemble hormones in some respects, cannot be included among them. For example, the sexual attractants of butterflies are, like hormones, produced and secreted by special glands; minute amounts cause a specific reaction in the receptor organ (the antenna of the male), which eventually leads to a state of copulative readiness. Unlike hormones, however, the substance is not secreted into the blood but outside the body; it does not serve humoral correlation within the organism but communication between individuals.

Referring to Starling's original definition, Bethe[1] called such substances 'ectohormones'; the name has been used by some authors but rejected by others. The most common definition of hormones to-day is that they are the products of endocrine glands. This should not be lightly expanded and diluted; in fact, it would be preferable to create and define a new term.

We propose, therefore, the designation 'pheromone' for this group of active substances. The name is derived from the Greek *pherein*, to transfer; *hormōn*, to excite. Pheromones are defined as substances which are secreted to the outside by an individual and received by a second individual of the same species, in which they release a specific reaction, for example, a definite behaviour or a developmental process. The principle of minute amounts being effective holds. The pheromones, messenger substances between individuals, thus take their place as a group beside the hormones, the gamones and the termones. Having stated that pheromones act on individuals of the same species, they must be differentiated from other stimulating substances, like phagostimulants, scents of flowers and insect repellents, which Bethe included among the ectohormones. Incidentally, strict species-specific activity is not required; certain overlaps between closely related species may occur.

There are various ways in which the recipient organism can detect pheromones. In a review shortly to be published, olfactory pheromones are distinguished from orally acting ones. The former, which can act over considerable distances, are perceived by chemoreceptors, from which nervous stimuli are sent to the central nervous system. If this released a certain behaviour, ethologists would place the pheromone concerned into the category of 'release stimuli'. The introduction of the term has been criticized for that reason (Verheijen-Voogd, C., personal communication). We nevertheless, on biological and biochemical grounds, regard it as sensible to mark off the pheromones from other chemical stimuli like food odours and others, and from optical, acoustic and similar releasers, as special messenger substances. It seems to us a fundamental difference whether an organism reacts to certain stimuli of the environment or creates for itself a means of communication of this kind. A clear definition of the pheromones and their specific action in particular cases should be of importance both to biochemical and to ecological research.

Among the active substances comprising the pheromones, most research has been carried out on those found in insects[2]. The queen substance of bees[3] and that of termites[4] inform the colony about the presence of the queen; if they are lacking, certain behaviour patterns and ovary development in the workers result. They act through the mouth, as do the active substances of the functional reproductives of termites, which inhibit the production of supplementary reproductives[5]. Should the hypothesis be confirmed, that royal jelly contains a specific developmental substance, formed in the lateral pharyngeal glands of the nurses, this, too, would be a pheromone. It is scarcely surprising that in the social insects in particular many pheromones are found, for these materials serve the social life of these animals.

The sexual attractants of butterflies and moths[6,7], cockroaches[8] and other insects, as well as the recognition odours of Hymenoptera[9,10], act through the olfactory sense. Lastly, the following substances also appear to fall into the category of pheromones: the sexual attractants of the Crustacea[11], the warning substance of the minnow[12], and probably also the territory-marking substances of the Carnivora, though here much remains to be solved.

The action of pheromones taken up orally can occur in two different ways. First, they can be perceived by the gustatory sense, thus making them absolutely analogous to the group of 'olfactory pheromones'. Apparently, the queen substance acts in this way (Butler, C. G., private communication). Secondly, there is the possibility that they may be resorbed in the digestive tract and develop their specific action by diffusing into the blood. This mode of action has not been proved in any special case. Therefore, we regard it as not yet expedient, or at least premature, to split the concept or make two definitions (for example, 'pheromones' acting through the senses and 'telemones' acting through the blood system). Chemoreception (basically a biochemical effect, too) and action of a hormone need not be contradictory; there are numerous examples of sensory stimuli or psychological excitations causing hormone secretion and of hormones releasing psychological states or behaviour patterns (nest building, parental behaviour). Finally, it is not easy to distinguish experimentally between sensory and biochemical effects, and therefore a clear classification is often just not possible.

The definition of pheromones has been discussed with several colleagues working in the field, and has found approval by A. Butenandt, Munich; C. G. Butler, Rothamsted; D. B. Carlisle, Plymouth; R. Chauvin, Burs-sur-Yvette; P. T. Haskell, London; B. Kullenberg, Uppsala; D. Schneider, Munich; R. Stumper, Luxemburg. We therefore throw the definition given above open for discussion and hope that it will prove itself in practice.

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Carotenoid Pigment in *Spirobacillus cienkowskii* Metchnikoff, a Pathogen of Cladocera

Cladocera are often coloured red by hæmoglobin in their blood[1]; another red pigment has been found in specimens infected by *Spirobacillus cienkowskii* which Metchnikoff[2] described from *Daphnia magna* Straus. The bacterium passes through a series of stages within the cladoceran and causes it to assume a bright red colour.

As a general rule less than 1 per cent of a cladoceran population shows signs of infection, but I have recently found a population of *Simocephalus vetulus* O. F. Müller in which up to 2 per cent of the individuals were infected. Several specimens of *Sida crystallina* (O. F. Müller) from the same body of water were also found to be infected with the same bacterium.

About three hundred infected specimens of *Simocephalus* were ground up in water and then centrifuged

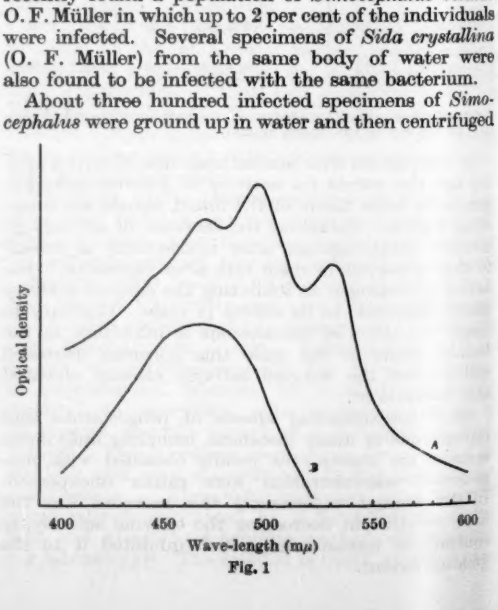

Fig. 1

at low speeds to leave a cloudy red suspension which consisted almost entirely of bacteria. When this suspension was centrifuged at 9,000 r.p.m. the bacteria were all spun down and a colourless fluid was left. This demonstrates that the pigment is confined to the bodies of the bacteria and is not a host reaction. The bacterial sludge was treated with acetone, when the pigment was easily extracted, then taken into petrol ether (boiling point, 60–80° C.) after dilution of the acetone with water. The solution in petrol ether was dried over anhydrous sodium sulphate and examined in a spectrophotometer. Absorption peaks were found at 470, 495 and 530 mμ (Fig. 1,*A*). The last two peaks are in fair agreement with those of rhodoviolascin and those of α-bacteriopurpurin, which is probably a demethylated form of rhodoviolascin[3]. The first peak is about 10 mμ too far towards the red end of the spectrum. The explanation for this was found when uninfected specimens of *Simocephalus* were treated in the same way as the infected specimens. An olive-green supernatant fluid was left after centrifuging; when this was treated with acetone it turned orange. The orange pigment was taken into petrol ether after dilution of the acetone water phase with more water. The absorption curve of the petrol ether solution is shown in Fig. 1,*B*. The single peak at 470 mμ agrees with that of astacene derived from astaxanthin which was present in the form of a green carotenoprotein. The presence of a small amount of astacene in the extract from the infected specimens would account for the apparent bathochromic displacement of the first peak of the bacterial pigment.

It is evident from these observations that the red pigment is a carotenoid of the α-bacteriopurpurin type, and that it is confined to the bacteria. There is an indication that the pigment is at least partially derived from carotenoid present in the host, because the patches of carotenoid protein which normally occur in healthy *Simocephalus* are changed to red when the pigment-bearing cells are infected with the bacterium.

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Adaptive Synthesis of Nitrate Reductase in Higher Plants

Adaptive production of enzymes in higher plants is not widely recognized, although two examples have been reported[1]. Nitrate reductase systems are adaptive to nitrate and nitrite in micro-organisms[2,3] and studies with cauliflower[4] have suggested a similar adaptive character in higher plants. Tang and Wu[5] obtained more direct evidence of the adaptive character of this enzyme in rice seedlings germinated for five days under sterile conditions and Rijven[6] reported similar results for wheat embryos germinated for 24 hr. These experiments, however, involved relatively prolonged periods of contact between inducer and tissues undergoing both rapid cell division and expansion.

We have found in numerous tests that production of nitrate reductase activity can be rapidly induced in small fragments of leaves excised from cauliflower

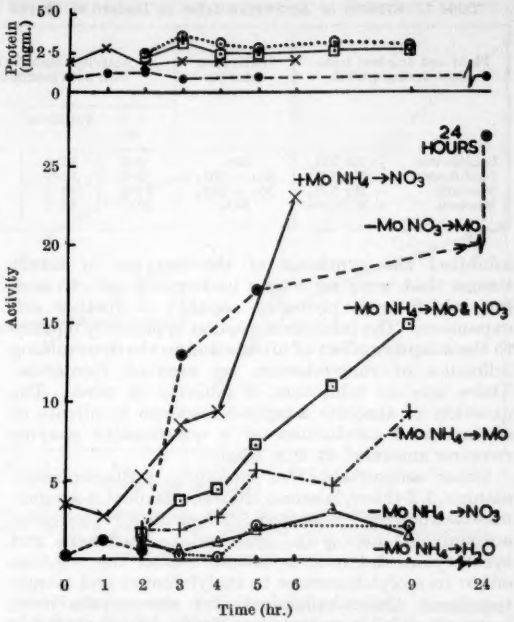

Fig. 1. Effect of infiltration with water, molybdenum, nitrate and molybdenum plus nitrate on the development of nitrate reductase activity (mμmole NO_2/15 min./mgm. protein) in excised leaf fragments of cauliflower grown with different nitrogen and molybdenum supplies. Mo at 5 μgm./ml. and NO_3 at 2·48 mgm./ml. in infiltrating solution

(*Brassica oleracea* var. *botrytis*), white mustard (*Sinapis alba*) and sunflower (*Helianthus annuus*). Fig. 1 shows results of experiments in which nitrate or molybdenum, or both, were introduced, by vacuum infiltration, into excised fragments of partially or fully expanded leaves of cauliflower grown in sand culture with ammonium sulphate or nitrate each with or without molybdenum. Rapid production of enzyme activity occurred on the introduction of nitrate into leaf tissues grown with ammonium sulphate, often apparently after a lag-period of about 1 hr. The introduction of molybdenum into leaves of plants deficient in molybdenum and grown with nitrate had a similar effect, resembling that observed in fungi[2]. Tissues of plants grown with ammonium sulphate but without molybdenum responded little or not at all to either factor alone, but rapidly developed activity when both were present.

The increases in enzyme activity greatly exceed corresponding changes, if any, observed in soluble protein content. The conclusion that protein synthesis is involved in the production of enzyme activity is supported, however, from studies with antimetabolites, some of which are known to inhibit protein synthesis. Table 1 shows results for cauliflower and mustard obtained with actidione, 1 : 2-dichloro-4-(*p*-nitrobenzenesulphonylamido)-5-nitrobenzene (DCDNS) and polymyxin *B*-sulphate introduced simultaneously with the other factors. From the concentrations ranging between 20 and 300 μgm./ml. of inhibitors in the infiltrating solutions, we tentatively estimate that the concentrations resulting in the cells were of the order of 5×10^{-6} *M* for actidione and 7×10^{-5} *M* for 1 : 2-dichloro-4-(*p*-nitrobenzenesulphonylamido)-5-nitrobenzene. Polymyxin was present at 2 mgm./ml. in the infiltrating solutions. All three antimetabolites markedly

Table 1. Effects of Antimetabolites as Inhibitors of the Synthesis of Nitrate Reductase in Excised Leaf Fragments

(1) Plant and nutrient treatment during growth		(2) Infiltration medium	(3) Activity ($m\mu M$ NO_2/15 min./mgm. protein) in extracts prepared 6–9 hr. after infiltration with medium shown, with (+) or without (−) inhibitor, or with water (O) but omitting activating treatments in column (2):								
			Actidione			DCDNS			Polymyxin *B*		
			+	−	O	+	−	O	+	−	O
Cauliflower	− Mo NO_3	Mo	6·5	27·8	2·5	19·7	30·2	1·5	12·2	83·2	0·0
Cauliflower	− Mo NH_4	Mo + NO_3	3·5	29·0	0·0						
Mustard	− Mo NH_4	Mo + NO_3	11·2	61·0	1·5	5·0	61·0	1·5			
Mustard	+ Mo Urea	NO_3	20·7	64·0	24·0	22·9	52·0	29·0	28·2	67·0	40·2

inhibited the synthesis of the enzyme in intact tissues that were no longer undergoing cell division but which were probably capable of further cell expansion. The inhibition applied apparently equally to the adaptive effect of nitrate and to the determining influence of molybdenum on enzyme formation. There was no inhibition of activity *in vitro*. The question of absolute adaptive response to nitrate or of increased production of a constitutive enzyme remains unsettled at this stage.

Other antimetabolites, including *p*-fluorophenylalanine, β-2-thienylalanine, chloramphenicol, 8-azaguanine, 2-thiouracil, 5-methyl-2-thiouricil, streptomycin, aureomycin, neomycin, gramicidin, bacitracin and tyrothrycin, did not, as tested, inhibit the response either to molybdenum or to molybdenum and nitrate together. Chloramphenicol and aureomycin may, however, inhibit protein synthesis less in cell-free preparations from plants[7] than from bacteria, and even bacteria may show varying tolerance to the effect of chloramphenicol on the adaptive synthesis of nitrate reductase[8].

The results in Fig. 2 suggest that nitrate reductase is relatively labile *in vivo* and may decrease in excised or attached leaves with time unless stabilized by the continued presence of the substrate. Other experiments have shown that infiltration with the inhibitory antimetabolites alone, of tissues already possessing activity, causes a further marked decrease in activity with time as compared with the effects of water as control. It is possible, therefore, that the enzyme is de-adaptive and that there is a rapid 'turn-over' in terms of simultaneous synthesis and breakdown. In the absence of a significant substrate concentration there would be a steady net decrease, greatly accentuated in the presence of an inhibitor of synthesis.

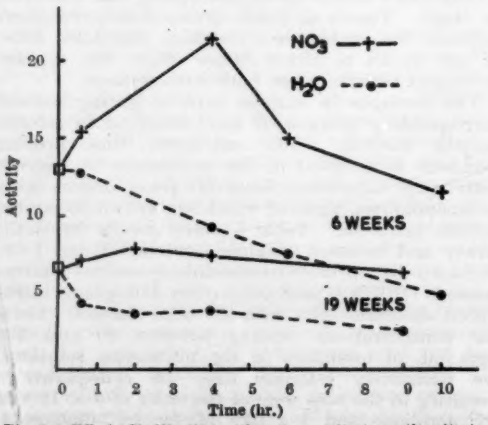

Fig. 2. Effect of infiltration with water or nitrate on the nitrate reductase activity ($m\mu M$ NO_2/15 min./mgm. protein) of excised leaf fragments of cauliflower plants 6 weeks and 19 weeks old grown with molybdenum and nitrate. NO_3 at 2·48 mgm./ml. in infiltrating solution

The full details of this and continued investigations will be published elsewhere. We wish to thank Dr. D. W. Woolley of the Rockefeller Institute, New York, for a generous gift of 1 : 2-dichloro-4-(*p*-nitrobenzenesulphonylamido)-5-nitrobenzene. The award of a Colombo Plan Overseas Studentship to one of us (M. M. R. K. A.) is gratefully acknowledged.

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Effects of Gibberellic Acid on Development of Autumn Colour and Leaf-fall of Deciduous Woody Plants

Gibberellic acid does not affect petiole abscission in *Coleus* explants[1], but we have found that treatment of some intact deciduous woody plants with gibberellic acid markedly influences development of autumn foliage colour and leaf-fall.

Gibberellic acid was applied as an aqueous spray (0·005 per cent gibberellic acid, 0·01 per cent 'Tween 20', 1·0 per cent glycerol) to all leaves of a selected branch on each plant; a comparable branch was sprayed with the inert constituents of the spray fluid, but on no occasion did this control treatment produce any observable effect as compared with unsprayed parts of the plant. The first application of spray was made on August 11, 1958, and thereafter at weekly intervals.

Little or no effect was noticed with *Acer rubrum* L., *Castanea sativa* Miller, *Fagus sylvatica* L., *Quercus robur* L., or *Ulmus procera* Salisb. Gibberellic acid delayed development of autumn colours and leaf-abscission in the following: *Acer pseudoplatanus* L., *Betula verrucosa* Ehrh., *Fraxinus excelsior* L., *Liriodendron tulipifera* L., *Parthenocissus tricuspidata* Planch., *Prunus avium* L. and a *Rhododendron* × *molle* cultivar. The most striking effects were

noticed with *Fraxinus excelsior*, *Prunus avium* and *Acer pseudoplatanus*; all leaves were still quite green on November 21, whereas all leaves from untreated branches had fallen. Only slightly less striking was the effect on *Liriodendron tulipifera*; on November 21 nearly all treated leaves were still green, whereas all other leaves remaining on the tree were bright yellow.

In complete contrast, development of autumn colour and abscission of short shoots and leaves of *Taxodium distichum* Rich. was advanced by treatment with gibberellic acid. The leaves turned bronze in colour shortly after the first treatment, and all leaves on treated branches had fallen by October 20; whereas bronzing of leaves on untreated branches was only beginning at that date, and leaf-fall was only partial on November 21.

Shoot extension had ceased in most of these plants at the time of the first treatment. Lateral and apical buds resumed activity, and new shoots and leaves were formed as a result of treatment with gibberellic acid in *Acer pseudoplatanus*, *Betula verrucosa* and *Liriodendron tulipifera*.

Thus most species treated with gibberellic acid gave one or more of the following responses: delay in development of autumn foliage colour, delay of leaf-abscission, renewal of shoot growth. These are characteristic responses to long-day conditions[2,3], and this result affords one more example of the induction by gibberellins of typical long-day responses[4]. The anomalous result with *Taxodium distichum* awaits explanation.

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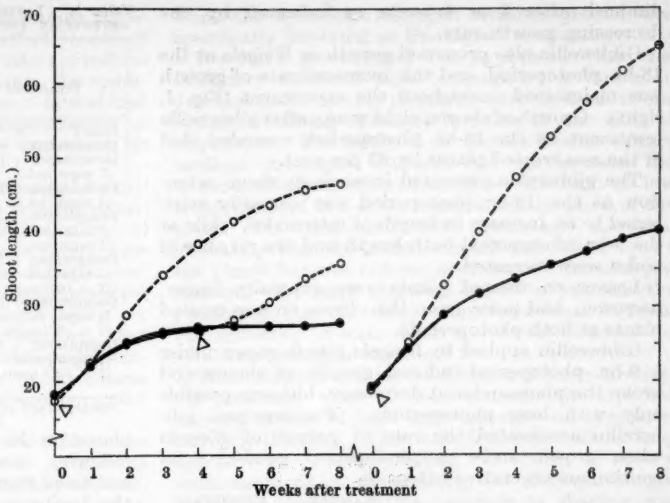

Fig. 1. Growth-rate curves illustrating the effect of gibberellin on the vegetative extension of *Weigela* cl. 'Vanicek' grown at 9-hr. (left) and 18-hr. (right) photoperiods. ○ - - - ○, treated with gibberellin; ●——●, untreated. △, Time of treatment with gibberellin

Gibberellin Effects on Photoperiod-controlled Growth of *Weigela*

Weigela, a woody ornamental plant, produces uninterrupted vegetative extension when grown at photoperiods in excess of 14 hr., whereas at shorter photoperiods (<14 hr.) vegetative growth ceases, and the plant enters a dormant condition[1–3]. This communication describes the replacement of the photoperiodic requirement for the vegetative development of *Weigela* with gibberellin applied to plants grown under a short photoperiod, and the acceleration of growth under a long photoperiod.

Two-year-old plants of *Weigela* cl. 'Vanicek' were grown in pot cultures in a greenhouse at an 18-hr. photoperiod and 16° C. night temperatures until growth-rates were well established (shoot elongation of 4·0 cm./week). Plants were selected for uniformity, pruned to five vegetative shoots, and six plants subjected to each of the following treatments: (*a*) retained at an 18-hr. photoperiod; (*b*) treated with gibberellin and retained at an 18-hr. photoperiod; (*c*) transferred to a 9-hr. photoperiod; (*d*) treated with gibberellin and transferred to a 9-hr. photoperiod; (*e*) transferred to a 9-hr. photoperiod and treated with gibberellin after dormancy was induced (4 weeks). Gibberellin treatment consisted of a single foliar spray of 50 p.p.m. (acid equivalent) of potassium gibberellate (potassium gibberellate was presented by Merck and Co., Inc., Rahway, N.J.) plus 0·1 per cent 'Tween 20' (polyoxyethylene sorbitan monolaurate supplied by courtesy of the Atlas Powder Co., Wilmington, Delaware) as a wetting agent. All plants were exposed to 9 hr. of natural daylight. Those under an 18-hr. photoperiod were exposed for an additional 9 hr. to artificial light (30 foot-candles from 60-watt incandescent-filament lamps).

A single foliar spray (50 p.p.m.) of gibberellin on *Weigela* subjected to the 9-hr. photoperiod resulted in continued shoot elongation during the course of the experiment. Comparable plants not treated with gibberellin ceased vegetative extension (Fig. 1, left), and formed rosettes after three weeks. Dormancy, induced by a short (9-hr.) photoperiod, was broken, and growth-rates in excess of those in non-treated plants grown at an 18-hr. photoperiod were established. After eight weeks the length of shoots on plants treated with gibberellin at the 9-hr. photoperiod exceeded that of the non-treated plants at the same photoperiod by 65 per cent. The growth of shoots of the treated plants in the short photoperiod (treatment *d*) compared favourably with, and even exceeded (by 15 per cent) those for the non-treated plants retained at the 18-hr. photoperiod (treatment *a*). Thus, the photoperiodic requirement for vegetative elongation and breaking the photo-induced dormancy was replaced with gibberellin. The effect of gibberellin, at the short photoperiod, began to

diminish after 3 or 4 weeks as indicated by the decreasing growth-rate.

Gibberellin also promoted growth in *Weigela* at the 18-hr. photoperiod, and this increased rate of growth was maintained throughout the experiment (Fig. 1, right). Growth of shoots, eight weeks after gibberellin treatment, at the 18-hr. photoperiod, exceeded that of the non-treated plants by 63 per cent.

The gibberellin-promoted increase in shoot extension at the 18-hr. photoperiod was primarily attributed to an increase in length of internodes, while at the 9-hr. photoperiod both length and the number of nodes were increased.

Leaves on treated plants were generally longer, narrower, and paler green than those on non-treated plants at both photoperiods.

Gibberellin applied to *Weigela* plants grown under a 9-hr. photoperiod induced growth of shoots and broke the photo-induced dormancy, hitherto possible only with long photoperiods. Furthermore, gibberellin accelerated the rate of growth of *Weigela* when grown under a photoperiod conducive of continuous vegetative extension.

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Interaction between Kinetin and Indoleacetic Acid in the Control of Bud Reactivation in *Splachnum ampullaceum* (L.) Hedw.

It has been shown[1] that the apical region of the gametophore of *Splachnum ampullaceum* (L.) Hedw. inhibits both lateral bud reactivation throughout the gametophore and protonematal regeneration from the base of the gametophore. These apical dominance effects could be replaced by the application of indoleacetic acid to the tips of decapitated plants.

Recently, Wickson and Thimann[2] presented evidence which indicates that apical dominance in *Pisum sativum* in terms of the inhibition of lateral bud reactivation is governed by an interaction of kinetin or kinetin-like factor and auxin.

The experiments described in the present communication were undertaken with the following questions in mind: (1) Is an interaction between kinetin and auxin similar to that found by Wickson and Thimann responsible for reactivation phenomena in the gametophore? (2) If so, are the mechanisms of correlation inhibiting lateral bud reactivation and protonematal regeneration from the base of the gametophore identical or different for these apical dominance effects? This question remained an open one in the investigation mentioned above[1].

The male strain of *Splachnum ampullaceum* was used. Plants were reproduced vegetatively and the gametophores treated were always 20–21 days old. They were grown on Beijerinck's inorganic solution plus 1 per cent agar. The *p*H of the medium was adjusted to 6·0. The plants were kept under continuous artificial illumination with fluorescent (daylight) lamps. The compounds tested were administered in small blocks containing 2 per cent agar placed on the tips of decapitated plants immediately following decapitation. Lateral bud reactivation and basal regeneration were examined four days after the beginning of the treatment. The blocks were changed twice per day over the four-day period. The amount of bud reactivation realized was taken as number of branches/number of axils × 100. The results are given in Table 1. Kinetin was obtained from the H. M. Chemical Co., Ltd., Santa Monica, California.

Table 1. Lateral Bud Reactivation and Protonematal Regeneration Four Days after the Beginning of Treatment

Treatment	Percentage of bud reactivation	Reactivation of basal bud*	Length of longest branch (mm.)	No. of protonemata
Intact	0	0	—	28
Decapitated + water	84	70	0·418	46
Decapitated + IAA (1 mgm./ml.)	0	0	—	31
Decapitated + K (1 mgm./ml.)	90	100	0·350	41
Decapitated + IAA (1 mgm./ml.) + K (1 mgm./ml.)	79	80	0·291	33
Decapitated + IAA (1 mgm./ml.) + K (1×10^{-1} mgm./ml.)	60	40	0·258	31
Decapitated + IAA (1 mgm./ml.) + K (1×10^{-2} mgm./ml.)	45	10	0·220	30
Decapitated + IAA (1 mgm./ml.) + K (1×10^{-3} mgm./ml.)	42	0	0·125	29

*Determined as number of most basal branches/10 plants × 100.

It may be seen from these results that the apical region inhibits lateral bud reactivation completely at this stage of gametophore development and that it has a depressing effect on the realization of regenerative potentialities at the base of the gametophore. Both these apical dominance effects can be replaced by the application of indoleacetic acid (IAA) at the given concentration to the tip of the decapitated gametophore. Kinetin (K) is seen to have a strong antagonistic effect on the action of indoleacetic acid in that it promotes lateral bud reactivation in the presence of indoleacetic acid. Kinetin does not seem to have any effect in counteracting the action of indoleacetic acid on basal regeneration.

These results indicate, therefore, that an interaction between kinetin and indoleacetic acid may control reactivation of lateral buds in the gametophore similar to the situation described by Wickson and Thimann for *Pisum sativum*. Since kinetin does not counteract the effect of the apex or indoleacetic acid on the depression of basal regeneration, it may be concluded that the mechanisms of correlation mediating apical dominance in terms of the inhibition of lateral bud reactivation and the depression of basal protonematal regeneration are not identical.

Since both kinetin and indoleacetic acid have to migrate from the tip of the decapitated plant to its base, the site of protonematal regeneration, it could be maintained that the failure of kinetin to counteract the effect of indoleacetic acid in this latter phenomenon may be due to differences in the translocation of these two compounds, for example, due to differences in inactivating principles. To test this possibility, the percentage of reactivation of the most basal bud was examined for the various treatments. The results are given in the second column of Table 1. They indicate that kinetin also antagonizes the inhibitory effect of indoleacetic acid on reactivation in the most basal bud. Since this bud is rather close to the base of the gametophore, the site of basal regeneration, it may be concluded that differences

in translocation between the two compounds probably cannot be the basis for the ineffectiveness of kinetin in counteracting the inhibitory effect of indoleacetic acid on basal regeneration. Hence the mechanisms governing correlative inhibition of lateral bud reactivation and basal protonematal regeneration by the apical region of the gametophore appear to be different from each other.

It should be mentioned here that Gorton and Eakin[3] have investigated gametophore initiation in the protonemata (induction of "dauermodifikation"[4]) of *Tortella caespitosa*. Bud initiation was found here to be inhibited by high concentrations of auxin, and was strongly stimulated by kinetin. Kinetin reversed the inhibition of bud formation brought about by napthalene acetic acid. It seems, therefore, that certain stages in the induction of "dauermodifikation", that is, bud initiation in the protonemata, and lateral bud reactivation in the gametophore may be mediated by the same mechanism.

This study was supported by a grant from the National Research Council of Canada. Technical assistance by Miss Veronika Ruf is gratefully acknowledged.

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Temperature and Symbiotic Nitrogen Fixation

Moderately high temperatures have been found to exert a specific inhibitory effect on symbiotic nitrogen fixation. The results of an experiment illustrating this effect are given in Table 1.

Table 1. Effect of Temperature, Inoculation with *Rhizobium*, and Potassium Nitrate on the Yield and Percentage Protein Nitrogen of Subterranean Clover (Means of Four Replicates)

Treatment	Yield of dry matter per tube (mgm.)		Protein nitrogen in plants (per cent)	
	20° C.	30° C.	20° C.	30° C.
Without nitrogen or *Rhizobium*	38·0	35·2	1·35	1·54
Inoculated with *Rhizobium*	54·5	35·3*	2·66	1·69*
With potassium nitrate	56·8	62·0	2·59	2·55
Standard error expressed as percentage of mean	4·9 per cent		4·3 per cent	

* Interaction between form of nitrogen (*Rhizobium* v. potassium nitrate) and temperature is significant at $P < 0{\cdot}001$ for both yield and percentage protein nitrogen.

For this experiment, subterranean clover (*Trifolium subterraneum* L. var. Bacchus Marsh) plants were grown on nitrogen-free nutrient agar in test-tubes which were stood in temperature-controlled waterbaths in a glasshouse. The results show that the uninoculated plants responded normally to nitrogen treatment at both temperatures. By contrast, plants inoculated with *Rhizobium* fixed nitrogen and grew normally only at the lower temperature. The inoculated plants were well nodulated at both temperatures. Thus the symbiotic nitrogen fixation process was specifically inhibited at the higher temperature.

We have investigated the hypothesis that this inhibitory effect of high temperature is due to a decrease in the supply of soluble carbohydrate to the nodule, resulting from an increase in the rate of respiration. The addition of sucrose to the culture medium in aseptic cultures did not increase the amount of nitrogen fixed at either the high or low temperature. The sucrose increased the yield of the plants but decreased the percentage nitrogen, indicating that the added sucrose was taken up by the plants but was not required directly for nitrogen fixation. We have therefore begun to examine the possibility that the high temperature has induced the deficiency of some other metabolite essential for symbiotic nitrogen fixation.

These findings also raise a number of other interesting problems. One of these concerns the reported harmful effects of high light intensity on symbiotic nitrogen fixation. This was first reported as long ago as 1935[1,2], when shading was shown to have a remarkable effect in breaking the nitrogen-hunger period in legumes. This response to shading was interpreted in terms of an effect on light intensity and photosynthesis. In our experiments we have been able to obtain marked responses and apparently normal growth of clover under the conditions of high light intensity of our summer by cooling the plants. It would appear that there is a need to determine in greater detail the relative effects of high temperature and high light intensity on symbiotic nitrogen fixation.

The significance of these findings in relation to the culture of legumes under experimental and field conditions is also an important matter for investigation. We have evidence that these effects are of importance in the culture of legumes in glasshouses in warmer weather, not only where the plants are grown in test-tubes, but also for larger pots. In fact the present work arose from observations made during the course of a pot culture experiment conducted during 1957, when it was found that subterranean clover grown in soil in pots made of clear polystyrene plastic were stunted and pale green in comparison with the larger dark green plants in corresponding enamelled pots. The reason for this difference was traced to the considerably higher soil temperature in the clear plastic pots. Since becoming aware of this effect we have obtained unmistakable evidence of suboptimal symbiotic nitrogen fixation in clover grown in various kinds of pots where soil temperatures have exceeded about 25° C.

We have no direct evidence on the possible effects of high temperatures on symbiotic nitrogen fixation under field conditions. In view of the temperatures involved it would seem that such effects may be of significance, particularly under irrigation in the warmer months, or in tropical and sub-tropical environments.

Full details of the experiments that have been done on this problem will be published elsewhere.

D. R. Meyer
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Division of Plant Industry,
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Sept. 25.

[1] Orcutt, F. S., and Fred, E. B., *J. Amer. Soc. Agron.*, **27**, 550 (1935).
[2] Fred, E. B., Wilson, P. W., and Wyss, O., *Proc. U.S. Nat. Acad. Sci.*, **24**, 46 (1938).

Electrophoretic Patterns of Mealworm Proteins

The literature concerning insect proteins is, generally, represented by analyses of single developmental stages, usually immature, hæmolymph being the principal fluid investigated. The results of these studies show that the protein component fluctuates during development[1–4]. This communication shows the variations for the protein component of the mealworm *Tenebrio molitor*, during its developmental stages. The method employed, electrophoresis, seems to be a useful facility for investigations of this nature, since electrophoretic patterns of proteins are distinctive. Specific pattern characteristics have been reported for developmental stages of mammals[5], closely related species of reptiles[6,7], and amphibians[8,9].

The insects were raised in the laboratory on a diet of chicken mash and grain and a daily ration of water. Eggs, laid in white flour, were harvested daily, and white larvæ, pupæ and adults were collected within one hour following their emergence. In this manner timed records were maintained for each phase of the life-cycle. Approximately 100 mgm. of eggs, newly emerged and 14-day-old larvæ were separately homogenized in 1 ml. of water in a tissue homogenizer. The posterior abdominal segment of pupæ and adults was severed and the body contents extruded into separate weighing vials containing 1 ml. of water until 100 mgm. had been collected. The samples were centrifuged and the supernates retained for electrophoresis. 0·02-ml. volumes of extract were applied to Whatman No. 1 filter paper strips for analysis ('Spinco' electrophoretic system, barbital buffer *p*H 8·6, ionic strength 0·05, 5 m.amp., 16 hr.). The strips were dried at 120° C. for 30 min., stained with light green *SF*[10] and scanned with a recording densitometer ('Spinco Analytrol').

Fig. 1. Paper electrophoresis patterns of the mealworm *Tenebrio molitor*, at various stages of development. Extract, 0·02 ml., was applied at 0 cm.; anode is to the right

The electrophoretic patterns in Fig. 1 show two distinct anodal fractions for all stages except the 14-day-old larvæ. The slower migrating fraction shows a well-defined band between −1 and 1 cm. from the point of origin. The faster fraction is well resolved between 4 and 6 cm. from the point of origin.

A comparison of the four stages discloses a uniformity in pattern for the slow fraction. Its concentration decreased as each phase of the developing mealworm progressed towards maturity. The fast fraction patterns are more variable. The peak is greater than that of the slow fraction for the egg and 5-day-old pupæ, approximately equal for the adults and the 9-day-old pupæ, and lower for the remaining groups. The eggs and pupæ also show alternation of the high peaks for the two fractions during their respective growth periods. A similar pattern prevails for the 1-hr. and 5-day-old pupæ. The trough separating the two peaks is relatively low for the ova and adults. The mid-pattern of the pupæ depicts a distinct rise and fall in concentration with increasing age.

These results show, generally, the direction of change for each stage of development and suggest the influence of basic growth activities. The results display the same type of variation as do morphological and physiological factors in bringing about protein changes in response to a modification of immature tissues for the subsequent building of the mature structure.

This study suggests the value of paper electrophoresis in revealing characteristics of insect proteins for investigating the comparative physiology of life-cycle activities.

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Oct. 17.

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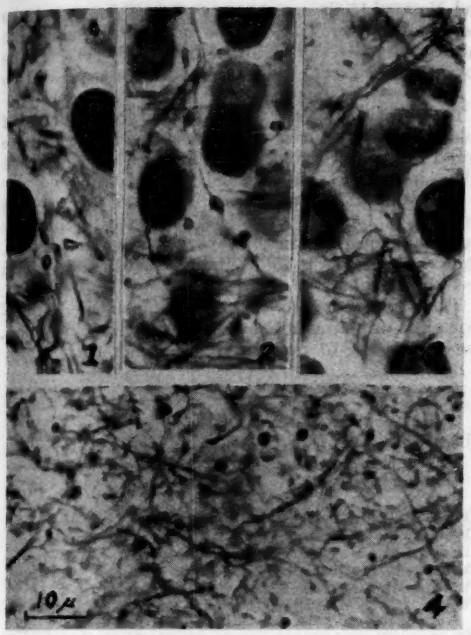
Environmental Temperature and the Reptilian Nervous System

It has been found that the terminal plexus of the reptilian brain undergoes marked changes with the environmental temperature.

Lizards (*Lacerta viridis*) have been kept at 19° C. and at 32 ± 3° C. for periods up to 8 weeks. Some of the animals (twenty-four) were killed by perfusion with saline followed by 10 per cent neutralized formol saline under ether or urethane anæsthesia, and the brains were prepared by the Holmes method. Other



Figs. 1 and 2. The large-celled layer of the hippocampus. Animal kept at 19° C.

Fig. 3. The large-celled layer of the hippocampus. Animal kept at 32° C.

Fig. 4. The nucleus sphæricus. Animal kept at 32° C. All figures taken from Holmes's preparations at the same magnification

animals (five) were decapitated under ether anæsthesia and the brains prepared by the Nonidez technique. Observations have been confined to the large-celled layer of the hippocampus, the nucleus sphæricus (posterior hypopallium) and the nuclei of the seventh and eighth cranial nerves.

Lizards that had been kept at 19° C. for 8 weeks showed a large number of well-stained terminal rings and a few swollen fibres distributed among the cells of the large-celled layer of the hippocampus and in the cranial nerve nuclei (Figs. 1 and 2). The fine-fibre plexus of the nucleus sphæricus showed irregular staining suggestive of degenerative changes.

Animals that had been kept at 32 ± 3° C. showed relatively few rings in any of the cell groups investigated (Fig. 3). In the nucleus sphæricus a number of solid blobs 1–3μ in diameter appeared in the irregularly stained fibre plexus (Fig. 4). These blobs only appeared after the animals had been kept at 32° C. for about three weeks. They continued to increase in size and number up to eight weeks.

Lizards obtained fresh from the dealers showed the typical cold picture in some groups of animals and an intermediate picture in others.

These differences are independent of the anæsthetic or the method of preparation. It is probable that they are related to the neurofibrillar thickening that Tello[1] and Cajal[2] found in hibernating reptiles.

The changes that have been found may give further information about the nature of the finer terminals. Some of the appearances of rings, swollen fibres and blobs are suggestive of degeneration in fine terminal ramifications and could be mistaken for degeneration products of experimental lesions.

We wish to thank Miss B. Shirra for the histological preparations and Mr. J. Armstrong for the photographs.

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Oct. 24.

[1] Tello, J. F., *Trab. Lab. Invest. biol. Univ. Madrid*, **3**, 9 (1904).
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A Hepatotoxin from *Sporidesmium bakeri* capable of producing Facial Eczema Diseases in Sheep

A previous communication[1] reported that spores of a fungus identified as *Sporidesmium bakeri* Syd. contained the 'beaker test' substance found to be associated with toxicity of pasture samples on which the disease known as facial eczema had occurred.

In initial experiments mycelial felts grown on Raulin–Thom and Czapek–Dox media failed to produce liver lesions when fed to guinea pigs. The material so fed was also negative to the 'beaker test'. Subsequent experiments with a high-sporing strain of the fungus, grown on potato–carrot extract medium, produced liver damage in guinea pigs, indistinguishable from that obtained after feeding hepatotoxic grass. The material fed comprised a mixture of mycelial felts, spores and medium. Similar fungal material produced liver lesions characteristic of facial eczema in lambs. Later a clinical case showing typical icterus and photosensitization was produced.

The specific nature of the liver lesions was diagnosed in both guinea pigs and lambs by D. C. Dodd, of Ruakura. The assistance is acknowledged of D. J. Ross of the Soil Bureau and W. Crawley of Ruakura in cultural methods and E. P. White of Ruakura in chemical work.

Experiments are being planned to determine whether the hepatotoxin of this fungus is also responsible for facial eczema as it occurs in the field.

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[1] Percival, J. C., and Thornton, R. H., *Nature*, **182**, 1095 (1958).

A Bacterium with Fungicidal Activity

In a recent communication, Percival and Thornton[1] referred to the relationship between fungal spores and a test for hepatotoxic grass. It has since been shown that the fungus is *Sporidesmium bakeri* Syd. and is the source of the hepatotoxin which causes the specific liver damage which occurs in the disease known as 'facial eczema'. In connexion with this work, we have isolated a strain of *B. subtilis* which

has a marked inhibitory effect on the growth of this fungus on culture media. Further investigations are being carried out to determine its spectrum of antibiotic activity and its relationship to the fungus in the field.

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[1] Percival, J. C., and Thornton, R. H., *Nature*, **182**, 1095 (1958).

Rutin in Tobacco grown in a Greenhouse

It has been reported[1-3] that leaf from tobacco grown in a greenhouse contains no rutin and in general much less polyphenolic material than leaf from plants grown in the field, and it has been concluded that the filtering action of the greenhouse glass to ultra-violet irradiation is responsible for certain of these differences. However, Frey-Wyssling and Bäbler[1] were able to show that when greenhouse plants were irradiated with ultra-violet light the chlorogenic acid content of the leaves was increased, but that rutin was still absent, which implies that the apparent absence of rutin is not due to limited ultra-violet irradiation.

We have recently experimented in this Department with the flue-cured tobacco variety Hicks in order to see if satisfactory leaf can in fact be grown under glass. The plants were grown both in clay pots and polyethylene buckets containing washed quartz sand using the nutrient solution developed by McEvoy[4] supplied by means of a drip-feed system. The plants were handled in a similar manner to tobacco grown in the field; they were topped at sixteen leaves and suckers were removed as they appeared. The leaves were harvested as they became mature and cured in a small cabinet. After curing, the leaves had the appearance of tobacco grown in the field, and comparable plant yields were obtained.

Aqueous extracts of the green and cured leaves were examined for polyphenols by means of one- and two-dimensional paper chromatography[5], and in agreement with other workers it was found that the total amount of polyphenolic compounds was less than in field-grown tobacco. However, rutin (quercetin-3-rhamnoglucoside) was present in the extracts. No other flavonols or flavonol glycosides could be detected on the chromatograms. A useful spray reagent for the detection of flavonols consists of a freshly prepared mixture of equal volumes of boric acid (1 per cent in acetone) and citric acid (10 per cent in acetone). With this reagent the rutin spot turns yellow and shows a greenish-yellow fluorescence under ultra-violet light.

The rutin contents of several samples of cured greenhouse-grown tobacco were determined using a modification (Weaving, A. S., unpublished method) of the methods proposed by Wilson[6] and Guseva and Nestyuk[7]. It may be mentioned here that the method used by Turner[8] was not suitable owing to the interference by chlorogenic acid. The results obtained are given in Table 1 and are expressed on a moisture-free basis.

Table 1. Rutin Contents of Greenhouse-grown Tobacco

	Clay pot (per cent)	Polythylene bucket (per cent)
Third harvest	0·24	0·23
Fourth harvest	0·24	0·24
Fifth harvest	0·29	0·28
Sixth harvest	0·37	0·33
Seventh harvest	0·39	0·43

These rutin contents are much lower than those of field-grown flue-cured tobacco, for which we have found values ranging from 1·0 to 1·7 per cent (Weaving, A. S., unpublished results).

It has been shown by Penn and Weybrew that cultural and curing practices can greatly influence the polyphenol content of tobacco grown in the field, and this aspect is now under investigation with greenhouse plants.

Thanks are due to the Directors of the Imperial Tobacco Company (of Great Britain and Ireland), Ltd., for permission to publish this communication.

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A. S. Weaving

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The Imperial Tobacco Co., Ltd.,
Raleigh Road,
Bristol 3. Nov. 6.

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HISTORY OF SCIENCE

Inertial Navigation

The recent voyage of the submarine *Nautilus* below the polar ice has caused interest to be focused on the subject of 'inertial navigation'. This recalls to mind a communication which was published in *Nature* (7, 483; 1873). A correspondent, Joseph John Murphy of Co. Antrim, discounted the idea that "the instinct of direction in animals is of the same kind as the faculty by which men find their way" and suggested instead a mechanical analogy basically identical with 'inertial navigation', namely:

"If a ball is freely suspended from the roof of a railway carriage it will receive a shock sufficient to move it, when the carriage is set in motion: and the magnitude and direction of the shock . . . will depend on the magnitude and direction of the force with which the carriage begins to move . . ." ". . . every change in . . . the motion of the carriage . . . will give a shock of corresponding magnitude and direction to the ball. Now, it is conceivably quite possible, *though such delicacy of mechanism is not to be hoped for* [my italics, D. C.], that a machine should be constructed . . . for registering the magnitude and direction of all these shocks, with the time at which each occurred . . . from these data the position of the carriage . . . might be calculated at any moment."

Murphy went on to detail the possible mechanism by reference to the recording anemometers of his day, and even suggested dial indication of instantaneous distance and direction from the starting point.

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Oct. 9.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, January 5

PHOTOBIOLOGY GROUP (in Room 179, Darwin Block, Bedford College, Regent's Park, London, N.W.1), at 2 p.m.—Scientific Papers.

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO AND TELECOMMUNICATION SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. H. T. Prior, Mr. D. J. R. Chapman and Mr. A. A. M. Whitehead: "The Application of Transistors to Line Communication Equipment".

SOCIETY OF INSTRUMENT TECHNOLOGY, CONTROL SECTION (at Manson House, Portland Place, London, W.1), at 6 p.m.—Mr. J. C. Kubale: "Control Systems as Applied to Railways Signalling".

SOCIETY OF CHEMICAL INDUSTRY, LONDON SECTION (at 14 Belgrave Square, London, S.W.1), at 6.30 p.m.—Mr. C. M. Berners-Lee: "Some Uses of Electronic Computers in the Chemical Industry".

Tuesday, January 6

ROYAL AERONAUTICAL SOCIETY (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 3 p.m.—Dr. L. R. Shepherd: Lecture on Astronautics.

INSTITUTION OF CHEMICAL ENGINEERS—(at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. R. Ll. Rees and Mr. F. J. R. Taylor: "Feed Water and Boiler Water Standards in the Central Electricity Generating Board"; Mr. J. Arthurs, Mr. J. A. Robins and Mr. T. W. Whitefoot: "The Treatment of Water for an Industrial High Pressure Boiler Plant".

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENT AND UTILIZATION SECTIONS (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. J. H. Davis: "Silicone Electrical Insulation".

INSTITUTION OF MECHANICAL ENGINEERS, INTERNAL COMBUSTION ENGINE GROUP (at 1 Birdcage Walk, Westminster, London, S.W.1) at 6 p.m.—Discussion on "The Influence of Infinitely Variable Torque Conversion on Engine Design".

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS AND POLYMER GROUP (at 14 Belgrave Square, London, S.W.1), at 6.30 p.m.—Dr. W. Hechelhammer: "Polycarbonates—their Properties, Processing and Applications".

SOCIETY OF DYERS AND COLOURISTS, LONDON SECTION (joint meeting with the LONDON SECTION of the TEXTILE INSTITUTE, at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Prof. J. B. Speakman: "To Blend or not to Blend—That is the Question".

Wednesday, January 7

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. Dr. J. M. van der Vlerk (Leyden): "Problems and Principles of Tertiary and Quaternary Stratigraphy" (Fourteenth William Smith Lecture).

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 5 p.m.—Miss V. R. Cane: "Behaviour Sequences as Semi-Markov Chains".

INSTITUTE OF PETROLEUM (at 61 New Cavendish Street, London, W.1), at 5.30 p.m.—Mr. G. H. Clark and Mr. D. A. Davidson: "Petroleum-Based Launching Lubricants".

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, S.W.7), at 7.45 p.m.—Dr. R. C. Sutcliffe, F.R.S.: "The Nature of Weather Forecasting" (Second Evening Discourse).

Thursday, January 8

INSTITUTION OF NAVAL ARCHITECTS (in the Weir Lecture Hall, 10 Upper Belgrave Street, London, S.W.1), at 4.45 p.m.—Dr. J. C. Hudson, Mr. J. F. Stanners and Mr. A. G. B. Miller: "The Surface Preparation of Ship Plate (Outer Bottom Plating) for Painting".

INSTITUTE OF REFRIGERATION (at the Institute of Marine Engineers, The Memorial Building, 76 Mark Lane, London, E.C.3), at 5.30 p.m.—Dr. G. G. Haselden: "An Economic Evaluation of Large Ammonia Absorption Refrigerating Machines".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, London, W.C.2), at 5.30 p.m.—Dr. L. G. Brazier: First Hunter Memorial Lecture.

ROYAL AERONAUTICAL SOCIETY (at the Institution of Mechanical Engineers, Birdcage Walk, London, S.W.1), at 6 p.m.—Mr. R. Hafner: "The Tandem Rotor Helicopter".

Friday, January 9

PUBLIC SCHOOLS APPOINTMENTS BUREAU CONFERENCE (organized by the Plastics Institute, at the Borough Polytechnic, London, S.E.1), at 10.15 a.m.

ASSOCIATION OF APPLIED BIOLOGISTS (in the Meeting Room of the Royal Entomological Society, 41 Queen's Gate, London, S.W.7), at 10.50 a.m.—Symposium on "Insects and Public Health".

INSTITUTION OF ELECTRICAL ENGINEERS, MEDICAL ELECTRONICS DISCUSSION GROUP (at Savoy Place, London, W.C.2), at 6 p.m.—Discussion on "The Physiologists' Requirements for D.C. Amplifiers" opened by Dr. M. H. Evans and Dr. G. B. B. Chaplin.

INSTITUTION OF MECHANICAL ENGINEERS (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6 p.m.—Mr. R. R. Arnold and Dr. P. W. Whitton: "Stress and Deformation Studies for Sandwich Rolling Hard Metals".

SOCIETY OF DYERS AND COLOURISTS, LONDON SECTION (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Dr. J. L. Ashworth, Mr. H. B. Mann and Dr. T. H. Morton: "Optical Brightening Agents in Action".

Saturday, January 10

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Mr. W. Watson: "The Mizutori Ceremony of the Todaiji Temple in Nara: a Purification Ceremony After the New Year".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

CHIEF HORTICULTURIST (highly qualified, with an appropriate university degree, wide horticultural experience and preferably experience of tropical horticulture) IN THE DEPARTMENT OF RESEARCH AND SPECIALIST SERVICES, Ministry of Agriculture, Federation of Rhodesia and Nyasaland, to be responsible for advising on horticultural policy as well as formulating a suitable programme for horticultural research—The Secretary (R), Rhodesia House, 429 Strand, London, W.C.2 (January 17).

ASSISTANT LECTURER, Grade A (male), at H.M. Dockyard Technical College, Singapore, to teach Mathematics and/or Science—The Director (Y), Education Department, Admiralty, London, S.W.1 (January 20).

RESEARCH ASSISTANT (with a first- or good second-class degree in botany or zoology and training or research experience in cytology), to work on cytological effects of ionizing radiation in plants—Dr. G. R. Lane, Department of Botany, The University, Southampton (January 24).

LECTURER IN MATHEMATICS (PURE MATHEMATICS) at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, January 27).

LECTURER IN CHEMISTRY, a LECTURER IN PHYSICAL CHEMISTRY, and LECTURERS (2) IN GEOGRAPHY at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, January 30).

LECTURERS (2) IN ZOOLOGY at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, January 30).

RESEARCH ASSISTANT (university graduate with research experience and with a knowledge of poultry husbandry) IN POULTRY HUSBANDRY for duties which will involve the planning and execution of experiments concerned with husbandry problems, together with the interpretation of the results and the preparation of reports arising from the work—The Principal, Harper Adams Agricultural College, Newport, Shropshire (January 30).

LECTURER (honours science graduate, with experience in virology and in research methods) IN BACTERIOLOGY—The Secretary, The University, Edinburgh (January 31).

LECTURER or ASSISTANT IN STATISTICS in St. Salvator's College, St. Andrews—Joint Clerk to the University Court, College Gate, St. Andrews (January 31).

LECTURER/SENIOR LECTURER IN AGRICULTURE (BIOMETRICAL METHODS) and a LECTURER IN AGRONOMY at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, January 31).

LECTURER (with a degree in electrical engineering and preferably experience in one or more of the fields of light current engineering) IN ELECTRICAL ENGINEERING at the University of Queensland, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, January 31).

SENIOR TECHNICIAN (preferably with good qualifications in histology) IN THE DEPARTMENT OF ZOOLOGY, University of Auckland, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, January 31).

IMPERIAL CHEMICAL INDUSTRIES RESEARCH FELLOWS IN BIOCHEMISTRY, CHEMISTRY, ENGINEERING, PHARMACOLOGY, or PHYSICS—The Secretary, The University, Aberdeen (February 13).

IMPERIAL CHEMICAL INDUSTRIES RESEARCH FELLOWS IN PHYSICS, CHEMISTRY, BIOCHEMISTRY, ENGINEERING, METALLURGY and PHARMACOLOGY or any related subjects—The Registrar, The University, Liverpool (February 14).

LECTURER (with experience in one of the following fields of research: (*a*) adsorption and heterogeneous catalysis; (*b*) use of radioisotopes; (*c*) gas chromatography) IN PHYSICAL CHEMISTRY—The Secretary, The Queen's University, Belfast (February 14).

LECTURER IN MECHANICAL ENGINEERING—The Secretary, The Queen's University, Belfast (February 20).

PROFESSOR OF ANATOMY at the University of Queensland, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, February 28).

RESEARCH FELLOW (Ph.D. standard) IN THE DEPARTMENT OF BOTANY, to undertake research in the field of mycology and/or plant pathology—The Registrar, The University, Birmingham 15 (March 1).

LECTURER or ASSISTANT LECTURER IN ELECTRONICS—The Secretary and Registrar, The University, Southampton (March 14).

LECTURERS or ASSISTANT LECTURERS (with experience in at least one of the following fields: generation, transmission and/or distribution of electrical power, measurements, electrical machinery) IN ELECTRICAL ENGINEERING—The Secretary, The Queen's University, Belfast (March 20).

LECTURER IN BOTANY, a LECTURER IN ZOOLOGY and a LECTURER IN BIOCHEMISTRY—The President, University College, P.O. Box 399, Addis Ababa, Ethiopia.

PHYSICS TECHNICIAN (preferably with a knowledge of electronics or vacuum technique), for work on a high voltage accelerator—The Administrative Officer, R.B.U. Medical Research Council, A.E.R.E., Harwell, Berks.

SCIENTIFIC ASSISTANT (TECHNICIAN) (preferably with some experience of light engineering), to work on a project to develop special

equipment for use in biological research and industry—Prof. O. L. Zangwill, Psychological Laboratory, The University, Downing Place, Cambridge.

Technician (preferably with previous experience) for the Chemistry Laboratories—The Secretary, Royal Holloway College (University of London), Englefield Green, Surrey.

REPORTS and other PUBLICATIONS

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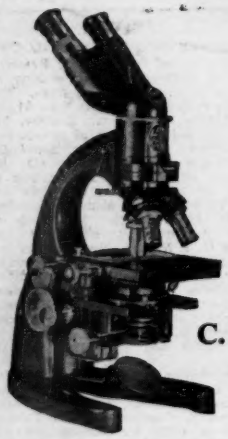

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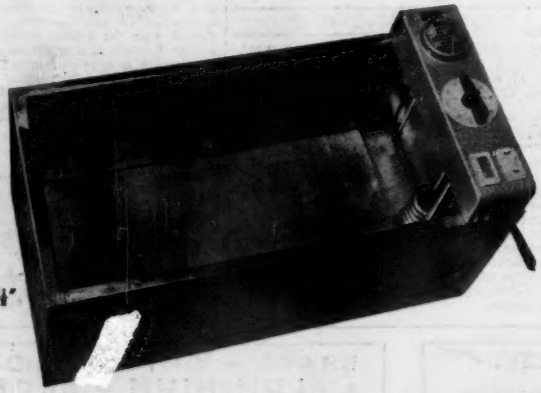

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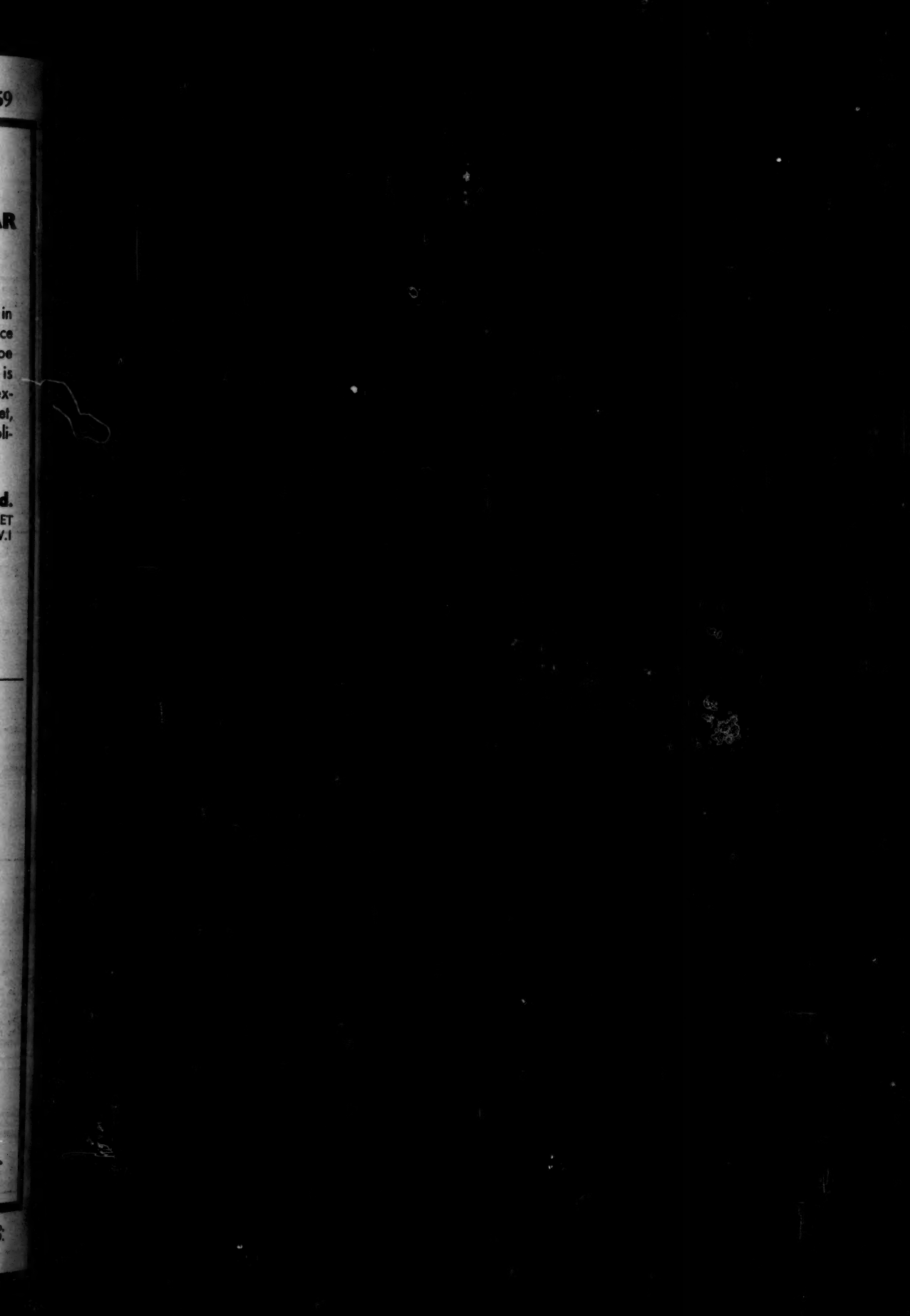
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